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Roger G. Pineda

Technology in Culture

A Theoretical Discourse on Convergence in Human-Technology Interaction

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ABSTRACT

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Technology touches so many facets of contemporary life that one is not necessarily conscious any more of how and why it affects daily experience. Awareness of technology's role often surfaces only when something goes wrong with a product. At that moment, people become aware of a misalignment between their ways of thinking, feeling and behaving, and the form/function of a product, presumably designed to make life easier. Equally ubiquitous and beyond daily awareness are cognitive, affective, and behavioural processes patterned by culture. It has been noted that cultural factors influence the perception and usage of technology. Understanding these processes is important to researchers, designers and engineers. They try to create products whose functions are aligned with people's needs. Achieving alignment means fundamentally helping people to realize goals and well-being. However, the processes employed towards this design goal need support from theoretical models that account for cultural similarities as well as differences. The scarcity of theoretical models, which could guide a culture-responsive technology design, has been identified as one of the root causes of the alignment problem. This dissertation addresses the facets of that problem from the interdisciplinary perspective of cognitive science. It explicates the relations between technology, culture, and life, and it synthesizes a theoretical understanding of a culturally-responsive human-technology interaction (HTI) research and design. This theoretical model suggests that awareness of similarities and differences in culture's influence on people's ways of thinking, feeling, and behaving with regard to technology would help mitigate the problem of misalignment. It could also open possibilities for innovations, which improve the quality of life. It proposes designating culture as a point of convergence for current research and design approaches in order to facilitate the integration and accumulation of knowledge on design-relevant cultural factors.

Keywords: culture, cultural human-technology interaction research, cultural materialism, form of life, meaning of technology, usability, values

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PREFACE

Human beings learn what can and cannot be done in given contexts. People also learn what they should and should not do. This monograph examines how people deal with the "must and must not" as well as the "should and should not" in relation to their environment and interaction with each other, with technology and through technology. The object of investigation is the design of technology, specifically the design of human-technology interaction (hereafter also referred to as *HTI*, or *human factors*). One asks once more: how can one make artefacts that truly help people in their daily life? While it is conceivable that people might eventually realize their actions purely through the power of their minds, they are still at a stage where they require technology and tools to help them transcend or modify the effects of natural physical laws. Hence examining the processes of technology artefact creation, and continuously questioning form and function from the perspective of utility to human life and experience will remain relevant for as long as people realize their actions through artefacts. The work in this monograph proposes that this enterprise can be approached from the perspective of culture because as a human artefact, culture provides materials for scientific analytical orientations that account for the variability of being human, and by extension account for the variance in thinking, feeling, and acting with regard to technology. Hence the present work proposes a theoretical model grounded on anthropological and psychological theories. This model could guide further theory and hypotheses development, which would support culture-responsive human-technology interaction research and design.

Accounting for variability means understanding both differences and similarities. The present work argues that examination and re-examination of cultural differences and similarities must be included in the research and design processes. Understanding human variability along the dimensions of culture, not only sensitizes people to the myriad possibilities in interactions with each other, it could also empower: one could truly become an active participant in the discourse about creation and consumption of technology.

Through the continuous history of human interaction with the environment, the perceived sociocultural constraints on human actions, in addition to the overall constraints of survival and reproduction, seem to trigger a desire for designed solutions. These solutions take the form of technology. Human dissatisfaction resonates in the notion of culture itself, because culture constitutes viable strategies "designed" by groups of individuals to overcome or modify the effects of ecological, chemical and physical constraints on human behaviour, and therefore life itself. In this sense, a culturally responsive approach to design is indispensible to the creation of technology-supported artefacts, which are aligned with people's biopsychological needs for well-being, a better life situation; that is, the various contexts of being, thinking, and acting in which people are situated in the course of daily life as well as in the course of a life span.

This theoretical discourse proposes convergent directions for human-technology interaction research and design, with the emphasis on research. This enterprise necessitates criss-crossing the borders between disciplines. It incorporates the implications of convergence of the separate streams of research in information technology, cognitive science, anthropology, and culture into a generative HTI research strategy. The concern is to address much earlier in the design process the design-relevant attributes, which can be utilized for concept development. At this stage neither the human-technology interaction practitioner nor the designer has a particular technology in mind. The objective is to collect data regarding people's needs as they are mediated or moderated by sociocultural and biopsychological factors.

Chapter one introduces the issues constituting the problem space regarding the conceptualization, design, and engineering of technology from the perspectives of users and creators of technology artefacts. Factors contributing to the problem are identified, and a proposal is put forward for dealing with the issue of universal versus cultural relativity in the context of human-technology interaction design and research.

Chapter two presents the theories of culture currently employed by researchers to operationalize the concept of cultural variability in human-technology interaction. A working definition of the culture construct is given.

Development of a cultural theory of technology is by necessity a multidisciplinary undertaking. Chapter three presents the idea of the co-deterministic relationship between technology and culture. The technology construct is defined as a by-product of this interaction, thereby establishing the primacy of culture in its relation to technology. The interplay between technology and culture is described in terms of theories from philosophy, anthropology, and psychology.

Chapter four introduces the current state-of-the-art approaches to studying human-technology interaction, all of which have components of what could be called a cultural cognitive science approach to HTI. Their strengths and weaknesses are examined in terms of their capacity to capture a holistic view of the human requirements for technology.

Chapters five, six, and seven present the arguments for using culture as the point of convergence for human-technology interaction research and design, as well as a lens for viewing and analysing human domains of action in order to systematically make explicit the effects of culture on attributes relevant to the design process. A synthesis of a path to a convergent theory of culture is offered in chapter six. Chapter seven further unpacks the assertion that technology is a cultural phenomenon, and suggests applying the prism-of-culture model to a holistic design paradigm: life-based design.

Finally, chapter eight discusses the implications of applying a convergent approach to the field of human-technology interaction design, and offers suggestions for future research directions.

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Helsinki, Finland 23.12.2013
Roger G. Pineda

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1 INTRODUCTION: DIMENSIONS OF THE PROBLEM

From a designer's point-of-view, cultural factors in the context of human-technology interaction are important because one wants to know what culture-specific factors affect people's thinking, feeling, and behaving with regard to technological artefacts (Adelabu, Yamanaka, & Moalosi, 2013; Alostath, Almoumen, & Alostath, 2009; Eune & Lee, 2009; H. Li, Rau, & Hohmann, 2011; Peranginangin, Chen, & Shieh, 2011; Sheikh, Fields, & Duncker, 2009). It has been argued that designers should create artefacts that people will find useful in simplifying their daily tasks as well as in giving them a sense of happiness (Norman, 2004). Hence, one can infer that as an individual or a "user", one wants to have technology-assisted tools that lessen physical and mental loads (Norman, 2002), as one goes through daily life performing actions alone or with others. With the increasing attention given to cross-cultural issues in HTI (e.g., Plocher, Rau, & Choong, 2012) one can infer that the primary problem is one of misalignment. That is, technology artefacts often do not match people's requirements inclusive of cultural factors.

A survey[1] of the HTI literature suggests general awareness among HTI professionals of the issues concerning misalignment between products and people's needs. But one of the problems they face is this: the difficulties of designing "culturally responsive" (C. D. Lee, 2003) technology are confounded by the fragmented state of research on the relationship between culture and HTI, combined with unexamined assumptions (Winschiers & Fendler, 2007) used during the design process.

The literature review for the present work has built upon previous reviews of the information systems (IS), and human-computer interaction (HCI) literature (Clemmensen & Roese, 2010; D. P. Ford, Connelly, & Meister, 2003; Kappos & Rivard, 2008; Leidner & Kayworth, 2006). These reviews indicate a trend towards inclusion of cross-cultural factors in the design process.

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[1] See the appendix for details on methodology used in the literature review.

Findings from the literature review point to a problem that could be characterized as follows:
(1) Design and engineering of technology artefacts often do not take into consideration culturally influenced variations in people's cognitive, emotional, and behavioural requirements. Design-relevant factors contributing to this situation are:
(1.1) Concepts used in the design process are assumed to be universal, but it can be argued that they are ethnocentric. Ethnocentrism, in the context of the present work, is defined "as the tendency to view the world through one's own cultural filters" (Matsumoto & Juang, 2008, p. 376).
(1.2) Usability issues remain the primary concern of cross-cultural HTI research. Usability research, however, often does not reveal cross-cultural factors that affect human-technology interaction.
(1.3) Overall, the state of research on the relationship between culture and technology seems to be fragmented.

This chapter introduces the current issues that concern cross-cultural human-technology interaction design. The enduring questions include: should one design universal or culture-specific artefacts? What should be the role of existing cultural models in methodology? How does one use them to inform designs? Are cultural and information processing theories mutually exclusive? These issues touch the goals, problems, criticisms, and theories of the discipline.

1.1 Impetus for cultural HTI: misalignment

Real and potential mismatches between people's requirements and technology are well-known issues to HTI professionals (Chapanis, 1996; Norman, 2002). The diversity of cultures and in people's use of technology around the globe adds another dimension to the problem. It challenges human-technology interaction researchers and designers to acquire a better understanding of the sociocultural preconditions to people's needs for technology in their daily lives. In the past two decades, research in HTI (Clemmensen & Roese, 2010; Kappos & Rivard, 2008; Leidner & Kayworth, 2006) has increasingly shown that culture-related factors affect the understanding and usage of technology. Researchers (e.g., Clemmensen, 2011b; Winschiers & Fendler, 2007) have also recognized that assumptions used during conceptualization of these artefacts are not universally applicable. Yet unexamined assumptions about concepts and design-relevant attributes that become part of products and services, which are distributed globally, continue to cause problems for people (Oren, Seth, Huang, & Kang, 2009; Reinecke & Bernstein, 2007). In other words, the form/function of products are misaligned with people's requirements.

It has been pointed out that "cultural issues are at the root of many of the problems people have with new machines: there are as yet no accepted conventions or customs for dealing with them " (Norman 2002, p. 85). This observation could be extended to problems encountered in new technology in general, and

ICT in particular. Researchers in the related fields of IS and HCI (Clemmensen, 2012; Kappos & Rivard, 2008; Vatrapu, 2010) emphasize two major dimensions of the problem. The first dimension concerns alignment of processes (i.e., development, usage, adoption and management of information systems within organizations) with known variance in the aspects of cultures. There has been recognition that the collective aim in addressing this problem should be to enable an appropriate level of "cultural fit" (Leidner & Kayworth, 2006) among organizational elements to ensure successful implementation of major information system projects. The second dimension concerns descriptions of people's relations to technology artefacts. This dimension underscores a need for integrative theoretical frameworks that are not purely ad hoc (Young, 2008).

Perhaps a more problematic situation for the HTI field in general is the temptation to superficially deal with issues of cultural factors affecting the understanding and usage of technology (cf. Chapanis, 1996, pp. 5-6 for observations about the tendency to give up examining human factors). It is understandable that in the fast moving and highly competitive information and communication technology industry, for instance, time pressures to release new products to global markets create an environment in which systems design and engineering teams might be reluctant to go into lengthy studies of cultural factors in order to acquire information on variables that must be considered in the design of products. According to C-H. Chen and Tsai (2007), Taiwanese HTI designers working on product and user interface design projects are required to complete the design process in three to six months. One of the design goals is to get the product out to the market in the shortest possible time, and systematically replace it with a new version after the product has been in the market for at the most, six months.

One can thus infer that there is a drive for developing global products, a process which often means designers use their intuition and knowledge of their own culture to create artefacts that are assumed to be globally acceptable. But whilst having a goal of designing products and services with universal interfaces and concepts makes sense from the perspective of economy of scale, it seems unreasonable to expect cross-cultural acceptance of these products without a better understanding of culture-related variance and similarity in people's preferences and behaviour.

However, even if design teams endeavour to align their creations to the requirements of multiple cultures, the paucity of integrative methods and theoretical frameworks for making explicit the cultural biases embedded in the design process, and for explaining cultural variables in people's relationship with technology, limits the application of a culturally aligned design (Young, 2008). One requires an approach that makes explicit the "cultural constraints" (Norman, 2002, p. 85) and "affordances" (Norman, 2002, p. 9) relevant to conceptualizing and designing new technologies.

A potential objection should give pause while considering the above proposition. One might reasonably object to the extra effort of gathering data to describe cultural factors' effects on the usage and acceptance of products and

services, particularly those that depend on a certain technology. The engineering and marketing disciplines, for example, already have several techniques in their repertory for drawing out the customer's requirements—e.g., marketing requirements studies and human factors requirements studies. One could further argue that people have the ability to adapt any unfamiliar product, inclusive of unfamiliar idiosyncrasies (Chapanis, 2004, p.22).

One might agree that people are very capable of figuring out how things work, but during the process of figuring out, including actions that could be deleterious to their well-being[2], they tend to miss out on the intended benefits of the product, and could more quickly ignore the product or service.

There is also evidence of product and service failures, or blunders that are attributable to failure to take cultural factors into consideration during the design, engineering, and marketing phases. The anecdotes are often humorous. The costs of these failures, however, are far from humorous. Cases in point according to White (2009): Euro Disney in Paris, Peugeot automobiles in the U.S. during the late nineteen seventies and early nineteen eighties, and the Ford Motor company in Japan.

The salient point in these cases: all the companies involved were (are) leaders in their industry and have sizeable international operations, yet they still overlooked cultural factors in the design, engineering and marketing of their products and services.

1.2 Universals: unexamined assumptions

The notion of universals as used in HTI design concerns the search for constructs that could be generalized across various design contexts, and therefore support creation of comprehensive theories as well as processes of the design practice. For example, until recently, the meaning of usability concepts has been deemed generally valid across professional and cultural boundaries (Winschiers & Fendler, 2007, p. 456). In this sense, the search for and application of universal notions in human-technology interaction theory and practice mirrors other scientific disciplines. In psychology, a universal is defined as "a psychological process that is found to be true or applicable for all people of all cultures" (Matsumoto & Juang, 2008, p. 27). For example having a worldview, defined as attitudes, beliefs, opinions, and values about the world, is considered a universal psychological process (Matsumoto & Juang, 2008 p. 27). Universal constructs based on empirically proven similarities in the understanding of their semantics enable creation and embedding of representations that overlay the functions of artefacts.

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[2] Leidner and Kleinworth (2006, pp. 357-358) noted that failures experienced by organizations are often attributed to cultural factors, and some of their examples of failures from the aviation industry were indeed lethal.

Recent experience in cross-cultural usability testing, however, has shown that even concepts thought to be invariant can be stumbling blocks for researchers (Clemmensen & Roese, 2010; Paterson, Winschiers-Theophilus, Dunne, Schinzel, & Underhill, 2011). The heart of the issue is whether concepts, which are relevant to all phases and processes of design, are deemed universal due to findings of empirical studies, or due to the designer's subjective view of universals. This is a non-trivial issue for it has direct implications on the design and understanding of technology artefacts.

Unexamined assumptions about concepts, which get embedded in the design of artefacts, contribute to the problem of achieving culturally relevant ICT design (Reinecke & Bernstein, 2007; Verran & Christie, 2007). It creates a blind spot that prevents designers from seeing design-relevant cultural factors.

During fieldwork to create a software program for Rwandan agricultural advisers, Reinecke and Berstein noted that participants in the testing of a provisional system, which was designed and implemented by a member of Western culture, could not optimally use the software in terms of information perception and handling. They reasoned that the difficulties emerged from too much choice of functionalities. Whilst variety in functionalities fits well with the Western-centric view, it did not fit into the Rwandan cultural frame (Reinecke & Berstein, 2007, pp. 201-202).

Assuming concepts as universal in designing content for ICT is problematic in multi-cultural societies, and it could be particularly problematic when the target audiences include indigenous communities. For instance, during a project in New Zealand to develop a persuasive game about quitting cigarette smoking, Khaled and colleagues (2006) found that New Zealand Europeans and Maoris differ in their perceptions of the roles of the concepts "social marketing", individual will power, influence of others, and social and cultural norms on smoking and cessation of cigarette smoking; therefore these differences have implications for the design of content for persuasive games. Such findings might not be considered new when put in the context of the related field of cross-cultural consumer research, wherein one of the key question addressed is whether variety of product offering should be done the same way everywhere, and wherein some studies, (e.g. Khandoker, Faruque, & Rahman, 2011), indicate that strategies will have to be modified for each market. Placed in the context of persuasive technology, however, skipping the research regarding the target culture and persuasion, and directly applying current assumptions present certain ethnocentric biases that the researcher/designer should be aware of. As Khaled et al. (2006) pointed out, the majority of current persuasive technology studies originate from the U.S., or a focus on products destined for American audiences.

It has also been noted that Western epistemology is embedded in the core of technology and not just in its interface. In a case study of a Yolngu aboriginal elder in Australia, Verran and Christie (2007) concluded that the very technical structure of digital technologies, based on Western principles and designed for representation, cannot enable aboriginal persons to negotiate their metaphysics

because the technologies cannot allow a performance embodying the uniqueness of each presentation; a feature that is essential to Yolngu worldview.

Western-centric assumptions embedded in the design of virtual worlds are different from cultural values found in Eastern or Islamic cultures, hence designers must be fully aware of the cultural fit versus technological fit issues (Yusof & Zakaria, 2007). Conversely, in designing an augmented reality environment in the Netherlands based on concepts influenced by Eastern metaphysics, Rauterberg (2006b) observes that cultural computing projects targeted to Western cultures should be realigned with their traditions. Rangaswamy and Singh (2009) note that the notion of mobile phones as private, personal and individual might not be valid in India. Human-technology interaction design processes require sensitivity to how inequality in power relations is enacted in design practice (Irani, Vertesi, Dourish, Philip, & Grinter, 2010). They also need a framework that helps uncover the designer's beliefs and biases (Eugene et al., 2009).

Thus far, the problematic aspects of concepts implicitly assumed as invariant have been characterized as primarily a problem of unexamined assumptions embedded in the constructs considered to be pan-cultural. Recent studies mentioned above suggest a more prudent approach to the application of such constructs in the methodology. In order to move toward more integrative approaches to designing culturally responsive artefacts, it seems to be necessary to reposition the notion of universals along the dimension of practice as well as theory. Repositioning the notion of universals on the level of practice means switching focus from finding differences and toward a search for similarities as a result of understanding cultural differences concerning people's thinking, feeling and interaction with technology. One can mirror the rationale for employing cross-cultural contexts as the source of inspiration for creating representations with equivalent meaning for most, if not all, of the participants (Bourges-Waldegg & Scrivener, 1998). This proposal has implications for studies in cultural usability and user experience, as well the movement toward integrative theoretical frameworks.

The concept of usability, as the experienced utility of using and interacting with technology and not exclusively as a measurement of effectiveness, efficiency and satisfaction, could be positioned as a pan-cultural construct if it incorporates an assumption for cultural variability in the notions underlying the term "experienced utility". This means one could posit culturally determined variability in people's experience and conceptualization of the utility of human-technology interaction, based on recent empirical findings.

Clemmensen (2009) calls for a focus on the broader experience of the utility of human-computer interaction, beyond the measurement of the standard metrics for usability. He suggests usability could be understood as a folk theory of the meaning of interacting with a technology product in various contexts, and this construct could be assumed universal because the underlying concepts for its metric are outcomes of human application of cultural models to technology usage. In the Western context, for instance, the usability concepts of *effec-*

tiveness, efficiency and satisfaction are examples of such outcomes. Recent research in usability evaluation (Winschiers & Fendler, 2007) in addition to findings of previously mentioned empirical studies present evidence questioning the validity of the standard definition of usability in non-Western countries. Hence in order to posit validity beyond Western contexts, a usability construct must account for the variable outcomes of human application of sociocultural aspects to the use of technology. A folk theory of what is an appropriate or inappropriate mixture of usability components for an artefact enables a more meaningful measurement of the experienced utility of an artefact.

It has been further suggested that in order for the field of human-computer interaction to move forward, the notion of usability must be considered universal. The universalism required for the study of cultural usability takes into account both evolutionism and relativism as empirical questions. Thus it acknowledges that cultural usability universals may or may not exist by requiring empirical documentation. Usability as a pan-cultural construct enables comparative measurement across cultures. An accurate usability measurement could be established by building it according to a target cultural context, considering during the process the internal cognition, the artefact's given affordances and the usability evaluation situations. (Clemmensen, 2009).

1.3 Problems with the focus on usability

Usability is about efficiency, and effectiveness in people's use of a given artefact to accomplish a task (Bevan, 2009). Usability research applied to technology design thus gathers data on people's behaviour with prototypes or existing artefacts, with the goal of eventually producing objects that meet both human and systems requirements for executing a task successfully. Identifying and describing culture-related variance in relation to usability issues seem to take most of the attention of researchers. Researchers attempt to resolve usability issues at the cross-cultural level concerning the aesthetic and social experience of the user. Culturally influenced preferences and bias affect what is considered an intuitive or user-friendly interface.

For example, half of the icons used in the iPhone released by Apple Inc. in 2007, while generally commonplace on phones in the United States and considered intuitive, failed a user recognition test deployed in China and India (Oren et al., 2009). Thus one of the current problems in cross-cultural human-computer interaction usability research is to figure out how an existing design can be realigned with relevant cultural factors to improve the usability of the artefact across different cultures. There is evidence—(e.g. Clemmensen, 2012; Irani et al., 2010; Paterson et al., 2011; Vatrapu & Suthers, 2010; Winschiers-Theophilus, 2009) however, suggesting that the current standard procedures in international usability research might have to be re-examined for their cross-cultural validity. This suggests that realignment must take place at both the design and process levels.

Clemmensen (2012, section 1.1.7) notes that both "user and evaluator effects" might influence the power of usability testing in culturally varied settings, and both must be factored into considerations of how to identify usability problems in such settings. As previously mentioned, researchers have realized that usability concepts might be too ethnocentric for application to usability research in non-Western settings. Winschiers and Fendler (2007, p. 453) observe, "[e]specially in a cross-cultural setting, it seems that the discrepancy between the specification and the understanding of usability is high and often leads to the development of unusable systems".

Resolving cross-cultural equivalence in usability procedures is one of the important issues; however, it does not resolve other problematic issues concerning the focus on usability in HTI. Observed mismatches between products and people might not be due to usability issues. Leikas (2009, p. 31) points out that people's willingness to adopt technology also depends on their values. Other studies indicate that HTI problems might be due to a mismatch between the epistemology embedded in a given product, and the dominant epistemology in the target culture (Verran & Christie, 2007). Usability studies also do not catch cross-cultural power dynamics that affect the transfer of technology across cultures (Irani, 2010).

Usability research provides important input to the creation of products that are easy to understand and safe to use. Current research in cultural usability however points to a critical weakness in the methods and concepts used in the important process of usability testing. Concepts such as effectiveness and efficiency as well as related metrics, which have been assumed to be universally salient, are not interpreted in the same way across cultures. Usability does not address the issue of culturally determined differences in the perceived need for technology-supported actions. As Leikas (2009, pp. 17-18) points out, "The design of appliances and services should not only prevent errors and guarantee productive usage of technology–it should fundamentally change these".

1.4 Fragmentation in research

Through a review of the literature on the relationship between culture and human-technology interaction, one can infer that the study of the relationships between culture and technology, human psychology and technology, and culture and psychology has been traditionally conducted via separate research streams. The study of people as users of technology has been around for decades, but research seems to remain dispersed. Several calls for integrative approaches have been made (Eugene et al., 2009; Karahanna, Evaristo, & Srite, 2005; Young, 2008). Their fragmented state seems to be due to a lack of integration between the research streams, and overall to the "eclectic" (Leidner & Kayworth, 2006) approaches used in research. In attempting to understand the best ways to do major information system design projects, it has been proposed that "laboratory-based usability studies are part of a solution, but they are best

preceded in a phased design process by careful field studies to ascertain how technology can fit into users' actual social and material environments, the problems users have that technology can remedy, the applications that will promote creativity and enlightenment, and how we can design humane technology that ensures privacy and dignity" (Nardi, 1996, pp. 8-9).

Leidner and Kayworth (2006, p. 373) note, "IS-culture research is eclectic in nature...." The present author's literature review of journal articles published in the past ten years indicates a similar trend. Studies have used single and multi-site surveys, case studies, ethnographic studies, content/archival analysis, and task observations in examining the relations between culture and ICT. Fifty-seven per cent of the articles explicitly integrated a cultural theory model in the methodology, while the rest did not use any cultural model. Those that used cultural models employed either single or multiple models.

The use of multiple-methods in itself is not considered problematic; the concern, however, is about how cultural models are employed in the methodology. For example in a prior survey of IS literature, it has been noted that whilst value dimensions have been commonly used among IS researchers who employed a cultural model in their work, they have not integrated the dimensions into development of hypotheses or theories. Instead, researchers have cited Hofstede's (1980/2001) work incidentally to set their study in the context of national culture. This lack of theory development consequently has reduced the value of the studies as a knowledge base to the IS field (D. P. Ford et al., 2003, p. 18). It has also been noted that processes of developing and using IS, as well as IS itself remain fragmented, a situation confounded by differing conceptualizations of culture amongst researchers (Kappos & Rivard, 2008, p. 602).

The problem space thus far has been described as a mismatch between people and products. Literature reviews suggest that solutions to this problem will require realignment with the cultural context both in the design and the processes supporting product design. With regard to the ICT industry, one should also situate the problem in an historical context.

1.5 Universal versus culture-responsive design

If one accepts the proposition that a culturally sensitive human-technology interaction design process aims to create artefacts, i.e. products and services, that are aligned with cultural dimensions relevant to people using them, one encounters the problem of whether it makes more sense to build a product with functions and features that are universal (i.e., culture-neutral), or culture-responsive. This problem is related to one that is well known amongst developers of information and communication technology: whether to build a "standard" or "custom" product. The problem is usually framed in engineering and economic terms. To build a product that is usable in various contexts, it is easier and costs less to build it with standardized features and functions, whereas

building it with customized features and functions adds complexity to the development processes as well as increasing costs.

The legacy of the standardize/customize dichotomy is reflected also in the contemporary work of designers involved in product and service development to the extent that they try to find standardized solutions that optimally address the issues and dynamics concerning both makers and users. The approach has worked well enough in the context of developing products for individuals and groups residing within one geographic locale, but developing artefacts for deployment internationally required a different process. Hence, the internationalization-localization process specific to information and communication technology was developed.

One can argue that the goals for a culturally responsive human-technology interaction design have been and are being met by the internationalization-localization process. Contemporary software products, for example, are more or less automatically configured with regard to the user's preferred language, character sets, numeric formats, date formats, time formats, currency formats, etc. But process shortcomings still materialize as products that encounter cultural usability issues, and eventually fail to gain acceptance in the international market.

The internationalization-localization process focuses on making an artefact usable across cultures, and is supposed to support the localization process by providing a basis. It separates, in effect eliminates, cultural elements—e.g., culture specific symbols, character set, etc.—from both the visible and invisible structures of the artefact. It therefore includes a culture-neutral design specification. The localization process, on the other hand, seeks to adapt culture-specific elements to the internationalized version of the artefact, by creating various language versions and culture-specific user interfaces. The internationalization-localization process has also been used to study culturally determined usability problems. This involves evaluating the differences between cultures and the problems these differences are likely to cause. It has been noted, however, that while this process has led to the creation of guidelines, design rules, technical advice and standards to assist interface designers, the process is not appropriate for designing artefacts intended to support inter-cultural communication and interaction. (Bourges-Waldegg & Scrivener, 1998).

Bourges-Waldegg and Scrivener (1998) question the value of the internationalization-localization process in the context of designing usable culturally relevant artefacts because of its over-dependence on guidelines, rules, standards and general advice that do not guarantee well-designed artefacts. Despite these misgivings, much of the research on cultural issues in human-computer interaction have emphasized finding cultural factors and/or cultural differences in order to identify common problem areas, and consequently apply this knowledge to develop internationalization-localization guidelines that nonetheless support the prominent approach of first creating internationalized or "universal" products, which are later localized. But as more cultural differences were discovered, more rules and guidelines were developed. Hence, the design

process became more complex and at the same time produced products that failed to meet the needs of many users.

The crux of the problem with the internationalization-localization process seems to be that it leads designers away from the more important question of why cultural factors and cultural differences cause usability problems, the knowledge that is most important to prescribing a more generally applicable, less ad hoc approach to cross-cultural human-technology interaction design. HCI literature indicates that the legacy of the internationalization-localization process remains embedded in the human-computer interaction design practice. The process continues to be useful in the context of creating local (i.e., national language) versions of technology artefacts. The increasing collective realization of its shortcomings creates interests in developing a more culture-responsive design approach. However, the notion of location or locality as a physically bounded space has to be realigned according to its current ambiguous ontological status in the context of the Internet, as well as in the context of globalization as a sociocultural phenomenon inclusive of a much more accelerated exchange of both material and immaterial artefacts, thus providing added impetus to developing a different approach.

The present work argues that the notions of universal and culture-responsive design do not have to be mutually exclusive. The more salient determining factor regarding the choice of label for both the design approach and resulting artefact will be the shared context, or domain of action (Winograd & Flores, 1988) in which people will interact with each other, and with culturally responsive technology.

1.6 Cross-cultural HTI research challenge

Human-technology interaction researchers and designers with the objective of achieving cultural fit face at least three problems. First is to figure out whether there are universal concepts that can be used in the design. Second is to identify the relevant cultural variables. And third is to create an integrative research framework that addresses the first and second problems. The first problem includes the issue of ethnocentric definitions of universals. The given concepts are too often based on unexamined assumptions and are not necessarily universally applicable. Values are assumed to underlie human practices that are supported by information technology. This assumption, however, becomes problematic for designing culturally responsive artefacts when the given values are also assumed to be universal.

Designers might not consciously embed their own cultural assumptions into their designs, but the resulting artefact will nevertheless embody the designers' cultural bias, which are grounded on unconscious pervasive cultural constructs (Nielsen, Bødker, & Vatrapu, 2010).

The second and third problems include the issue of using cultural theory. In a critique of positivistic research in cross-cultural human-computer interac-

tion, Vatrapu (2010) argues that most of the current explanations of cross-cultural differences in interacting with technology are tautologies. Other investigators (see e.g., D. P. Ford et al., 2003, pp. 9-10) in the information systems discipline similarly aim their criticisms at researchers' over-reliance on national level values—e.g., national value dimensions (Hofstede, 1980/2001) — to operationalize the construct of culture. The critiques, however, bewail the ways researchers employ national value constructs rather than the theoretical viability of the value dimensions.

The present work aims at the third problem. The notion of culture stands for a wide set of material and symbolic concepts (recent surveys of definitions of culture are provided, for example, in Berry, Poortinga, Breugelmans, Chasiotis, & Sam, 2011). Therein lie the challenges to accumulating methods and theories for studying culture's relationship to technology. A lack of a generally accepted definition of culture in the relevant reference disciplines such as anthropology or psychology contributes to the difficulties. As Marvin Harris noted, "The one dependable ingredient in anthropological definitions of culture is a negative one: culture is not what you get when you study Shakespeare, listen to classical music, or take courses in art history. Beyond that negative, confusion reigns" (M. Harris, 1999, p. 19). Without solving this dilemma, however, one can develop adequate approaches to solving technology design problems by adopting a definition of culture that is precise enough for the purposes of the inquiry, and by using a problem-solving epistemology—one that marks scientific advancement by an increased ability to solve problems, rather than getting closer to the truth (Laudan, 1977, pp. 119-120; Saariluoma & Oulasvirta, 2010, p. 318).

The present work adds another dimension to the third problem mentioned above: HTI professionals and designers of human-technology interaction, particularly as applied to ICT artefacts also face a challenge wherein human activities and cognitive processes are remediated through software, which in turn functions within a physical artefact. One can say this challenge is not any more limited to the ICT field, as embedded systems are applied to increasing number of artefacts, which were invented as mechanical systems, such as automobiles, airplanes, household appliances, and industrial machinery and control systems (Ebert & Jones, 2009; Gansel, Schnitzer, Dürr, Rothermel, & Maihöfer, 2013).

The notion of remediation is due to Bolter and Grusin (1999). It is defined as a representation of one medium in another medium. In the digital media technology context, for instance, a narrative can be represented in the medium of a book, which in turn can be re-represented in the medium of film, which in turn is re-represented in the medium of interactive digital games, and so forth, or eventually to another yet-to-be-invented medium. In remediating a domain of action[3] (i.e., human activities), designers have to consider both analogue and digital phenomena such as spatial contexts—whether a given activity is done at home, work, school or some other environment; biopsychological needs; affordances—including sociocultural ones; and constraints—i.e., material and

[3] Domain of action is elaborated in chapter 5.

sociocultural. This process helps the designer determine what attributes of a given human activity (cognitive and behavioural) could be supported by technology and represented by a symbolic (computer) system.

One also has to take into account the articulation of cultural categorization and cultural concepts on the semiotic and linguistic levels according to computer ontology, epistemology, and pragmatics (de Castro Salgado, de Souza, & Leitão, 2011; de Souza, Barbosa, & Prates, 2001; de Souza, 2013). This process of articulation could be problematic, for example, if there is an ontological conflict between the human narrative view and the computer database view of the domain of action, as in the case of the Aboriginal knowledge practice, which is non-representational in nature (Verran & Christie, 2007), and the relational database, which is implicitly conceptualized based on Cartesian principles (Pumpa & Wyeld, 2006). Metadata are implicitly embedded in the narrative and resist representation in a conventional relational database schema (Pumpa & Wyeld, 2006). Hence, a designer's assumptions regarding the symbolic functions for an artefact must be kept in the foreground in order to analyse and explicate the consequences of cultural differentiation in conceptualizations of the representative function of symbols.

Researchers and designers, moreover, have to be able to investigate the domain of action at different levels, including the level of systemic processes. There has to be a feedback circuit that allows analysis at the individual level (i.e., *emic*), and at the observer's level of abstraction (i.e., *etic*) and go back to the individual level again. The notions of emic and etic, as they are employed in the present work, trace their lineage to the anthropological research tradition, whereby emic descriptions and interpretations are derived from participant-oriented studies, and etic descriptions and interpretations are derived from observer-oriented studies (M. Harris, 1999, p. 31).

Marcus (2002) observes that the global diffusion of technology products and services and the resulting feedback have contributed to awareness among development, marketing, and business communities regarding the impact of world cultures on the design of user interfaces. There is impetus to ascertain the optimum characteristics of "suitably localized products and services based on market and user data to achieve both short-term and long-term success without having to develop many variations that might waste time and money in development, distribution, and maintenance" (Marcus, 2002, p. 15). In order to operationalize the search for culturally optimum product and service characteristics, however, one has to identify fundamental user interface components independent of variability in hardware and software platforms, user groups, and contents. Marcus (2002) identified five fundamental user interface components: metaphors, mental models, navigation, interaction, and appearance.

Other researchers have similarly argued for "a set of universally accepted design guidelines that are useful to developers" (J. Chakraborty & Norcio, 2009, p.13), but they proposed adopting cultural attributes, which are derived from works of several researchers, into a hybrid model, to help particularly digital game developers in their understanding of culture. These attributes are symbol-

ism, local variables (e.g., local language), individualism, colour and knowledge processing. The attributes compose a guideline for forming a user model during the design process. They also serve as a classification of known culture-related design pitfalls such as using inappropriate symbols or images (symbolism); jargon (local variables); inappropriate individualist-collectivist culture markers (individualism); inappropriate colour and mismatch in the demands of (game) software functions and cognitive style (knowledge processing).

Several investigators (Choi, Lee, Kim, & Jeon, 2005; Erumban & de Jong, 2006; Peranginangin et al., 2011; Zhang & Maruping, 2008) have demonstrated correlations between cultural and psychological dimensions with usage and diffusion of technology. But gaps in the findings and fragmentation in the research approaches have been noted (Clemmensen & Roese, 2010; Kappos & Rivard, 2008; Leidner & Kayworth, 2006; Marcus, 2002; Marcus & Alexander, 2007). Further research must fill the gap in hypotheses and theory development, and in the knowledge about design relevant attributes affected by culture. This knowledge is particularly salient, for example, to the development of ICT artefacts, such as augmented reality, into interactive digital media products and services, as well as for developing culturally responsive information and communication technology in general.

There are several other proposals for a cultural theory of human-technology interaction, and these proposals are discussed in chapter 3. The salient point is that current proposed theories seem to be targeted to specific contexts such as organizational work, and it is not yet clear how they could be applied across various HTI design domains.

Hence notwithstanding prior contributions to the literature of frameworks to study the relationships between HTI and culture, there is still a need for theory development and holistic approaches to gathering data on the sociocultural and biopsychological preconditions that might give rise to people's need for technology-based tools. Concentrating on notions of effectiveness, efficiency and satisfaction, in the usability research context, is useful for developing solutions to improve existing technology concepts, but such focus does not necessarily provide concepts for analysing the needs arising from people's actions and goals in daily life, in various cultural contexts.

1.7 Research purpose

The purpose of the present work is to contribute to the effort of narrowing the gap in theory development by *a priori* theorizing and deriving from the proposed theory an extension to a holistic design framework adaptable to different cultural settings. This approach could serve as a tool for human-technology interaction practitioners to determine the relationships between cultural factors, which are relevant to people's needs and activities, and to discover how these needs and activities could be supported by technology.

The present work's potential contributions to the human-technology interaction literature, and to HTI design research are two-fold: (1) the synthesis of a theoretical model for culturally responsive human-technology interaction that could serve as a framework in foregrounding latent needs for a designed technology solution as well as in describing and explicating the relationship of culture and human-technology interaction; and (2) the synthesis of a culturally responsive extension to a holistic research strategy, thus better enabling it to respond to the needs of human factor practitioners, designers, and systems engineers in designing and developing culture-relevant products and services for domestic (i.e. culture-specific) and global deployment.

To sum up, the current divergent state of research in human-technology interaction makes it difficult to apply the cumulative data on the relations between technology, culture, human psychology and behaviour to specific design projects, thus forcing researchers to work on an ad hoc basis, a situation which in turn contributes to further fragmentation. From this perspective, the problem of designing global or universal artefacts is a convergence problem. One could assert that culture is the appropriate point of convergence for a viable, parsimonious human-technology interaction research strategy. While acknowledging the divergent definitions of the construct culture, it nevertheless provides the key component of a strategy to systematically describe and explain the similarities and differences in human psychology and behaviour—that is, human factors—affecting human-technology interaction. Unpacking this concept requires explication of usage, in the present work, of the constructs culture and technology. It also requires examination of available theories explicating cultural variability in behavioural and cognitive processes. These issues are addressed in the next chapters.

2 CULTURAL VARIABILITY

Operationalizing cultural differences in technology usage, and determining technology's sociocultural meaning can be done through existing theories of culture, but this approach presents a challenge in the sense that given the myriad definitions of culture, the HTI researcher must explicitly formulate a working definition, which is applied to the project. As Matsumoto and Juang (2008, p. 12) note, there is no generally accepted definition of culture, but it is important to have a working definition for one's own use.

The disciplines of anthropology, philosophy, and psychology together provide a formidable source of descriptions and explications of what it means to be human. Understanding people's relationship to technology necessitates examination of the similarities and differences in the way they think, feel, and behave. To this end, this chapter reviews theories of culture that have been employed in human-technology interaction studies, as well as proposes an alternative theory that is relevant to the enterprise of human-technology interaction design.

What is culture? Definitions of the term culture are matters of controversy (Bauman, 1973). In anthropology for example, a researcher's definition of culture varies according to the epistemological pedigree of the research strategy being followed. Most of the anthropology and psychology literature on the study of culture refer to Edward Tylor's definition of culture. He wrote that culture is a "complex whole which includes knowledge, belief, art, law, morals, custom and any other capabilities and habits acquired by man as a member of ty. …Culture is a subject apt for the study of laws of human thought and action" (Tylor, 1871, p.1).

Presenting contemporary theories of culture proves to be difficult without starting with some assumptions about human nature. One perspective that serves as a basis for explaining both the pan-cultural and culture-specific phenomena is evolutionary psychology's view of human nature (Buss, 2001). Buss (2001) explains that the evolutionary psychology perspective of human nature proposes the notion of a linkage between human-developed strategies and reproductive success. Through the course of time, people have had to solve various social problems in order to adapt and survive. These social problems include

competing with rivals for food and sexual partners, attracting mates, giving birth and raising children, dealing with nature, forming successful work and social groups, and negotiating status hierarchies.

Hence universal biological imperatives are linked with a universal set of psychological problems, which must be solved to survive. All individuals and groups face the same problems of adaptation, and must develop ways to deal with them. These ways can be very group-specific due to the differences in the context of living, that is, in terms of ecological, biological and social factors. The ways that each group creates adaptive solutions become each group's distinct culture.

Culture both enables and constrains behaviour (Adamopoulos & Lonner, 2001, pp. 28-31). People use the notion of culture to explain many aspects of their lives. They use it to explain differences in the types of food they eat and the ways they eat them; their clothing and home life; and they use it to explain their activities, values, attitudes, and beliefs. The subjective elements of culture are psychological. Culture affects psychological processes such as attitudes, beliefs, norms, values and behaviours. It is not a static entity. It constantly changes, although slowly. Culture can exist on many levels: individuals are part of small groups, smaller groups are part of larger ones, and each group can have its own culture. This characteristic applies to ethnic groups and communities living in a large country, and it also applies to different hierarchical units of large companies. Culture provides rules for living and interaction. It provides a framework or hierarchy for making decisions, and sets standards for group cooperation and division of labour. Culture is often difficult to perceive because as a native of one's culture, one cannot easily recognize alternative ways of doing and being without first experiencing the alternatives, for example, by traveling to a different country and interacting with people in that culture; or without first being told that a certain group have a culture that is different from one's own. It could encourage, for example, individualism or interdependence. It defines what is right and wrong, what is acceptable and not acceptable. It also provides for social sanctions against unacceptable behaviour. (Matsumoto & Yoo, 2007).

As previously articulated, there is no generally accepted definition of culture. Most definitions present culture as something shared by members of a social group, that it is learned and transmitted. However, the notion that psychological constructs such as attitudes, beliefs, norms and values can be employed as measurable cultural constructs is relevant to designing culturally responsive technology from the perspectives of theory and methodology.

2.1 Cultural models

Models of culture and their underlying theories have been constructed traditionally to explain human diversity as well as commonalities and to provide a framework for cross-cultural research and analysis in various disciplines, many of which are today linked to the relatively young discipline of human-technology

interaction and its sub-disciplines. In psychology, cultural models are used to explain processes of the mind (Cole, 1996; D'Andrade, 1981; Schank & Abelson, 1977). In anthropology, cultural models frame the anthropologists' holistic examinations of cultures as they search for shared behaviour and knowledge (Hall, 1976/1981). Intercultural communications researchers have created cultural models to explain value orientation and systems, and the differences in values across cultures (G. H. Hofstede, 1980/2001) In the field of instructional design, models of culture are employed in the design and development processes of tools for supporting learning (C. D. Lee, 2003). Theories of culture generally acknowledge that dimensions of culture are subsumed in the human psyche. These dimensions include values and attitudes (Schwartz, 1992), communication style (Hall, 1959/1973) and cognitive style[4] (Witkin, 1950; Witkin, 1967). Theories addressing these dimensions are summarized in the following sections. Researchers currently employ several theories of culture, but the ones in dominant use are Hofstede's (1980/2001) value dimension and Hall's cultural communications theory (Hall, 1959/1973). They are used in the research methodology either exclusively or in combination with other theories of culture.

2.1.1 Culture and communication

Culture is a form of communication (Hall, 1959/1973, p. 28). Culture affects language lexicons and pragmatics; many cultural differences in pragmatics can be described in terms of communication style (Matsumoto & Juang, 2008). Edward T. Hall (1976/1981) identified two dimensions of culture, which impact intercultural communication: high-context versus low-context communication, and space-time orientation. The notions of high-context and low-context concern the way information is transmitted. No culture exits exclusively at one end of the continuum, but some cultures are considered high and the others low (Hall, 1976/1981). HTI researchers have employed these notions as an index of variability in communication styles.

According to Hall (1976/1981), in cultures with a high-context communication style, messages are often brief and light on background details. High-context communication style assumes that the receiver is familiar with the subject matter and therefore does not need background details. This communication style employs implicit and indirect messages. Meaning is found in the nature of the situation and the relationship between the communicators. Japanese, Chinese, and Korean cultures are examples of a culture that uses a high-context communication style (Hall, 1976/1981, p. 91). Low-context communication style uses lengthier or more elaborate messages. The message contains much background information on the subject matter. Low-context communication assumes that the receiver of the message might not be familiar with the subject. This style of communication involves the use of explicit and direct messages. Meaning is found

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[4] Cognitive styles have been defined as an individual's consistent patterns of organising and using information. They "allow a cultural group and its members to deal effectively with problems encountered in daily living" (Berry, Poortinga, Breugelmans, Chasiotis, & Sam, 2011), pp. 144-145. Cognitive styles are discussed fully in chapter 6.2.1.3.

through words. English, German, German-Swiss, Scandinavian and American cultures are typically associated with low-context communication; however, Americans are considered to be more in need of contexts (Hall, 1976/1981, p. 91). Misunderstanding or a sense of frustration often results when people from low-context and high-context cultures attempt to communicate. The low-context person wants more details and background information than a high-context person is able or willing to provide.

Polychronic and monochronic time orientations describe the ways culture structure the concept of time.

> "Monochronic time (M-time) and polychronic time (P-time) represent two variant solutions to the use of both time and space as organizing frames for activities. Space is included because the two systems (time and space) are functionally interrelated. M-time emphasizes schedules, segmentation, and promptness. P-time systems are characterized by several things happening at once. They stress involvement of people and completion of transactions rather than adherence to preset schedules. P-time is treated as much less tangible than M-time. P-time is apt to be considered a point rather than a ribbon or a road, and that point is sacred" (Hall, 1976/1981, p. 17).

Hall (1959/1973) also identified variations in space perception, which he categorized as intimate, social or public.

Edward T. Hall's work on contextual dimensions has contributed to the understanding of variation in how people perceive, use, and share information (Zakaria, Stanton, & Sarker-Barney, 2003). Hofstede (1980/2001, p. 30) notes that the notion of high and low context communication overlaps with the concept of collectivist and individualist continuum in national value dimension. It has found wide application in mass communication and business. The idea of low-context/high-context communication has been applied to cross-cultural computer-mediated communication (CMC) research to explicate variance in preferred communication style and design of user interfaces (De Angeli, 2009; H. Li et al., 2011). The literature reviews previously alluded to, suggest that application of the time-space orientation is rarely used in HTI studies. It seems, however, that there might be potential application to the early conceptualization stages of design.

2.1.2 Culture and values

Values presumably express individual choice, basic motivations, internalizations of social institutions, and shared cultural meaning systems (Fischer & Schwartz, 2011, pp. 1127-1128). Values are thus considered to be properties of cultures, and they have been used by researchers as indices of variability across national-level cultures (e.g., G. H. Hofstede, 1980/2001). This culture-comparative view of values assumes relative consensus on value priorities within cultural groups, and relatively large differences between groups, hence enabling differentiation of national cultures according to their prevailing values (Fischer & Schwartz, 2011, p. 1129). The previously mentioned reviews as well as the present author's survey of current HTI literature indicate researchers adopt value dimensions to contextualize the cultural model or models used in their cross-cultural studies. Two of the most commonly employed models, Geert H. Hofstede's (1980/2001) national

value dimensions, and Shalom H. Schwartz's theories of personal values (Schwartz, 1992) and national cultural value orientation (Schwartz, 1999) are summarized in the following sections. It is important to distinguish between the concepts of national cultural-level and individual-level values, for they allow researchers to systematically examine variations in value dimensions at different levels. National cultural values represent socially shared notions of ethically desirable behaviour; they are the basis of norms ruling people's actions in given situations (Schwartz, 1999, p. 25). Cultural values constitute a societal response to basic existential problems that all societies must face (G. H. Hofstede, Hofstede, & Minkov, 2010, p. 4; Schwartz, 1999, p. 26). In other words, at the national level, values characterize groups and societies, thus allowing for comparisons across cultures.

Individual or personal values represent motivated (i.e., desirable) goals, which guide actions, choices, appraisal of events and people, and explications of behaviour and evaluation (C. Kluckhohn, 1951/1952; Rokeach, 1973; Schwartz, 1992). Hofstede (1980/2001, p. 6) distinguishes between values as the desired and the desirable; that is, one must conceptually distinguish between what people actually desire (i.e., in reality) contra what they think they should desire (i.e., social desirability). This differentiation is methodologically salient, for the researcher must realize that one is dealing with two different kinds of values. The two should not be equated. Personal values influence an individual's perception and interpretation of events, as well as his or her choices, behaviour, decisions, and attitudes (Bardi & Schwartz, 2003; Maio, Pakizeh, Cheung, & Rees, 2009; Sagiv, Sverdlik, & Schwarz, 2011).

2.1.2.1 Hofstede value dimensions

Hofstede (1980/2001) presents a national cultural framework based on data from two rounds of survey between 1967 and 1973, and developed a set of dimensions to describe the notion of national culture. These national dimensions focus on human values. Culture is defined as "the collective programming of the mind that distinguishes the members of one group or category of people from others" (G. H. Hofstede et al., 2010, p. 6). "The 'mind' stands for the head, heart, and hands—that is, for thinking, feeling, and acting, with consequences for beliefs, attitudes, and skills. …[C]ulture in this sense includes values; systems of values are a core element of culture" (G. H. Hofstede, 1980/2001, p. 10). Culture is characterized as a collective phenomenon, because people living in the same social context share it. It has been emphasized that culture is learned rather than inherited (G. H. Hofstede et al., 2010, p.6). Culture is also distinguished from human nature, which is considered a universal aspect of mental programming, and an aspect that is inherited. Furthermore, culture is different from an individual's personality, which is characterized as partly learned and partly inherited (G. H. Hofstede 1980/2001, pp. 2-4; G. H. Hofstede et al., 2010, pp. 6-7). Culture consists of different layers situated at the national, regional, ethnic, religious, linguistic, gender, generation, social class, and (work) organizational levels (G. H. Hofstede et al., 2010, p. 18). These different levels reflect the different types of social group that an individual might associate with.

Cultural differences manifest in the symbols, rituals, heroes and values espoused by different groups (G. H. Hofstede, 1980/2001, p. 10; G. H. Hofstede et al., 2010, pp. 7-9). The core of culture constitutes values, which are preferences or feelings for a particular state of being. The national cultural framework consists of five dimensions, which are statistically distinct but are interdependent and could correlate in various combinations. These dimensions are used as indices for situating and comparing national groups along a value scale.

(1) Power distance pertains to power distribution. It is defined as the extent to which the less powerful members of institutions and organizations within a society expect and accept that power is unequally distributed (G. H. Hofstede et al., 2010, p. 61). High values in the power distance index indicate a centralized top-down approach to the exercise of power. Lower values indicate a more even spread of power at all levels of society.

(2) Uncertainty avoidance is the extent to which the members of a culture feel threatened by ambiguous or unknown situations (G. H. Hofstede, 1980/2001, p. 146). The uncertainty avoidance index measures the tolerance for ambiguity and uncertainty, particularly in the context of less structured or surprising situations.

(3) Individualism versus collectivism characterizes the ties between individuals in a society. Individualism pertains to societies in which the ties are loose. That is, everyone is expected to look after themselves and their immediate families. In contrast, collectivism pertains to societies in which people are integrated into strong cohesive in-groups, which protect individuals throughout their lives in exchange for unquestioning loyalty (G. H. Hofstede et al., 2010, p. 92). Asian cultures are typically associated with a lower value in the individualism index compared to Western cultures.

(4) Masculinity versus femininity characterizes emotional gender roles. Female values were found to not widely vary between cultures, whereas male values greatly vary between cultures. A society is called masculine when emotional gender roles are distinct—that is, men are supposed to be tough, assertive, and focused on material success, while women are supposed to be modest, tender, and concerned with the quality of life. A society is considered feminine when the emotional gender roles overlap. (G. H. Hofstede et al., 2010, p. 140).

(5) Long-term orientation versus short-term orientation characterizes a society's time orientation regarding the development of virtues. Long-term orientation stands for the development of virtues oriented towards future rewards—e.g., perseverance and thrift. Short-term orientation stands for development of virtues oriented to the past and present—e.g., respect for tradition, preservation of "face", and fulfilling social obligations (G. H. Hofstede et al., 2010, p. 239).

Literature reviews note that researchers in the IS and HCI disciplines predominantly applied value dimensions developed by Hofstede to their studies. Ford et al. (2003) acknowledge the contribution of Hofstede's national dimensions to furthering research, and enabling a cumulative tradition in the fields of general and international business management, as well as in psychology and

sociology, but the authors expressed concern about the ways IS researchers have used the dimensions.

2.1.2.2 Schwartz personal and national values

While Hofstede's work provides a framework for examining variations in the patterning of values on the national level, Shalom H. Schwartz presents a model for studying these patterns on the individual level as well as on the national level. Schwartz and Blisky (Schwartz & Bilsky, 1987; Schwartz & Bilsky, 1990) developed a conceptual definition of values, which incorporates five features of values that have been recurrently mentioned in the literature. "Values (1) are concepts and beliefs, (2) pertain to desirable end states or behaviours, (3) transcend specific situations (4) guide selection or evaluation of behaviour and events, and (5) are ordered by relative importance" (Schwartz, 1992, p. 4.) A sixth feature, "the relative importance of multiple values guides action" (Schwartz, 2009), was later added. Schwartz (1992) differentiates values from attitudes in terms of their generality (feature 3), and their prioritization (feature 5). Values are further differentiated in terms of the conscious motivational goals underlying them (Schwartz, 1992; Schwartz, 2009).

According to Schwartz's theory of value contents and structure, all values share a structure consisting of the formal features that he and Blisky identified; hence the structure of values is universal. The theory posits a typology of the different contents of values organized under ten value types: self-direction, stimulation, hedonism, achievement, power, security, conformity, tradition, benevolence, and universalism (Schwartz, 2009). These value types are summarized in Table 1. Empirical studies by Schwartz using the Schwartz Values Survey (SVS) instrument[5] in 41 countries support the universal recognisability of these values across cultures (Schwartz, 1994). Other studies support the theory across cultures, indicating similarity in the meaning of the ten value types in most cultures. This finding in turn allows researchers to compare different groups with regards to the value types (Davidov, Schmidt, & Schwartz, 2008; Spini, 2003). They are also considered to be nearly universal to the extent that their antecedents are three universal human requirements for existence: "needs of individuals as biological organisms, requisites of coordinated social interaction, and survival and welfare needs of groups" (Schwartz, 2009)[6].

The theory specifies dynamic relations among the value types—that is, the structure of value relations: actions taken to attain a given value or values have social, psychological and practical consequences that might be incongruent or compatible with the pursuit of other values. The patterns of relations in the value priorities manifest as a circular structure to value systems (Schwartz, 1996, p. 4-5; Schwartz, 2009, pp. 6-8). This feature is important to cross-cultural research because certain behaviour is sometimes predicted by one set of values in some cultural groups and by another set in others (Knafo, Roccas, & Sagiv, 2011).

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5 An alternative instrument, the Portrait Values Questionnaire, was also developed to measure the ten basic values in samples of children from age 11, of the elderly, and of non-Western educated persons (Schwartz, 2009, Schwartz et al., 2001).

6 Cf. M. Harris' universal structure of sociocultural systems (M. Harris, 1979, pp. 51-52).

TABLE 1 Schwartz value types.[7]

Summary of the Schwartz value types			
Value type	**Defining goal**	**Antecedents**	**Representative single value concepts[8]**
Self-direction	Independent thought and action—choosing, creating, exploring.	Needs for control and mastery; interactional requirements of autonomy and independence	Creativity, freedom, choosing own goals, curious, independent; [self-respect, intelligent, privacy][9]
Stimulation	Excitement, novelty, and challenge in life.	Need for variety and stimulation to maintain an optimal, positive level of activation.	A varied life, an exciting life, daring.
Hedonism	Pleasure or sensuous gratification for oneself	Pleasure associated with satisfying needs.	Pleasure, enjoying life, self-indulgent.
Achievement	Personal success through demonstrated competence according to social standards.	Competent performance, which brings resources for individual survival.	Successful, capable, ambitious, influential, influential; [intelligent, self-respect].
Power	Social status and prestige, control over people and resources.	Justification for differences in status as requirement for the functioning of society[10].	Authority, wealth, power; [preserving my public image, social recognition].
Security	Safety, harmony, and stability of society, relationships, and self.	Basic individual and group requirements.	Social order, family security, national security, clean, reciprocation of favours; [healthy, moderate, sense of belonging].
Conformity	Restraint of actions, inclinations, and impulses that might harm or upset others and the social status quo.	Requirements for individual self-restraint on inclinations that might disrupt and undermine smooth interaction and group functions.	Obedient, self-discipline, politeness, honouring of parents and elders; [loyal, responsible].
Tradition	Respect, commitment, and acceptance of one's cultural or religious customs and ideas.	Groups' developed practices, ideas, symbols, and beliefs representing shared experience.	Respect for tradition, humble, devout, accepting my portion in life; [moderate, spiritual life].

TABLE 1 continues.

7 Adapted from Schwartz (Schwartz, 1996, p. 3; Schwartz, 2009, pp. 3-6).
8 Value items derived from the first value survey instrument (Schwartz, 2009).
9 Values in brackets have multiple meanings across cultures. They are not used to compute standard indexes for values (Schwartz, 1996).
10 Parsons, 1951 as cited in Schwartz, 2009, p. 4.

TABLE 1 continued.

Summary of the Schwartz value types			
Value type	**Defining goal**	**Antecedents**	**Representative single value concepts**
Benevolence	Preservation and enhancement of the welfare of the members of one's in-group.	Basic requirement for smooth functioning of the in-group, and need for affiliation.	Helpful, honest, forgiving, responsible, loyal, true friendship, mature love; [sense of belonging, spiritual life, meaning of life].
Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people, and nature.	Needs for individual and group survival.	Broadminded, social justice, equality, world at peace, world of beauty, unity with nature, wisdom, protecting the environment; [inner harmony, spiritual life].

Schwartz's theory of national cultural value orientation (Schwartz, 1999) posits seven cultural value orientations, which constitute three cultural value dimensions. The theory has been validated on empirical data from 73 countries (Schwartz, 2006). The three value dimensions derive from societal-level needs to deal with three universal problems: (1) to define the nature of relations between a person and the group, that is the extent a individual is autonomous versus embedded in her or his group; (2) to induce people to behave in a manner conducive to the welfare of society. Polar solutions to this problem are labelled egalitarianism—people should consider the welfare of others as equal to their own, and hierarchy—a system of assigned roles to insure responsible and productive behaviour, a system that legitimizes unequal distribution of power, roles and resources; and (3) to regulate how people relate to the social and natural world. Cultural responses to this problem are labelled harmony—emphasizing understanding and appreciating the world as it is versus mastery—active self-assertion to master and direct the natural world (Schwartz, 2006, pp. 140-141).

The structure of value relations on the cultural level is similar to the one theorized for the individual level. Pursuit of a single value may have a positive or negative correlation with its bipolar opposite, and single values may have complementary relations (Schwartz, 1999).

A revision to both the concept and measurement of societal culture has been recently proposed due to the results of an empirical study demonstrating that cultural values have less consensus among individuals within countries as well as less variation between countries than once thought (Schwartz, 2013). Fischer and Schwartz (2011) demonstrated the existence of more variation in values rating between individuals within countries than variations between countries (country accounts for less than 12% of variance in self-ratings of values), thereby presenting a challenge to cross-cultural comparisons (e.g., G. H. Hofstede 1980/2001; Inglehart & Baker, 2000) using the cultural value dimension.

While Fischer and Schwartz's (2011) findings reinforce the validity of the cultural value theory, the proposition for a revised concept of culture discounts the dominantly prevailing assumption among cross-cultural psychologists that national cultures are the primary determinant of individuals' value priorities, and that there is consensus across individuals regarding the priorities. According to Schwartz (2013, p. 2):

(1) Culture is a latent, hypothetical construct. The various meanings, beliefs, practices, symbols, norms, and values of people in a society are manifestations of culture but they are not culture itself.

(2) "Societal culture is external to the individual. It is not a psychological variable. The normative value system that is the core of societal culture influences the minds of individuals but it is not located in their minds. It is an aspect of the context in which people live. To rephrase Hofstede's metaphor, culture is the 'programmer' of the mind, not its programming".

(3) "Societal culture underlies and is expressed in the functioning of societal institutions, in their organization, practices, and policies. …[T]hese institutions mediate the effects of culture on individuals".

Hence a "sociological perspective that traces value differences to social structural experience" (Fischer & Schwartz, 2011, p. 1129) has been proposed as a better account for the pattern of value ratings, variability across individuals within countries, and similarity in these priorities between countries (Fischer & Schwartz, 2011, p. 1137).

Schwartz's personal and cultural value theories have been rarely used in HTI research (it has been explicitly used in one study included in the literature review by the present author; they were not at all referenced in studies included in prior reviews previously mentioned). It seems, however, that Schwartz's theories could provide support for theory development (e.g., Khaled et al., 2006; Khaled, Barr, Biddle, Fischer, & Noble, 2009).

2.1.3 Culture and meaning: symbolic model

This section reviews the key concepts of interpretive anthropology, and discusses the issues concerning the analysis and interpretation of cultural dimensions. Clifford Geertz serves as a main figure representing the school of interpretive anthropology. To explain the epistemological justification for his work, Geertz said, "The concept of culture I espouse…is essentially a semiotic one. Believing, with Max Weber, that man is animal suspended in a webs of significance he himself has spun, I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretive one in search of meaning" (Geertz, 1973, p. 5). For Geertz, therefore, the practice of symbolic or interpretive anthropology is about explaining the inherent meaning of *webs*. It is not about shared meaning or artefacts. It is about the inherent meaning of, e.g. artefacts or objects.

The practice of social anthropology, moreover, is not about the techniques and methods of the enterprise. Rather, it is about the intellectual effort of pro-

ducing "thick descriptions", a term Geertz borrows from Gilbert Ryle (Ryle, 1971 as cited in Geertz 1973), in order to analyse and interpret cultural phenomena through a semiotic framework. He writes thick descriptions by re-interpreting what is already taken for granted in everyday life. He characterizes culture as a manuscript—i.e. a text, a publicly acted document. Even though culture as text is ideational, it does not exist in someone's head; though it is immaterial, it is not an occult entity (Geertz, 1973, p. 10). He argues that once human behaviour is seen as symbolic action that signifies, the question of whether culture is patterned conduct, or frame of mind or a combination of both loses sense. The salient question about human behaviour concerns meaning, and not ontological status. He criticizes proponents of cognitive anthropology—i.e., the school of thought, which claims culture consists of psychological structures that are used by individuals or group of individuals to guide their behaviour. His criticism extends as well to the structural anthropologist's insistence that we need not study behaviour, because culture is better studied purely as a symbolic system by isolating its elements, specifying their relationships and creating a generalized characterization. In contrast, he claims behaviour must be studied with some exactness because it is through social actions that cultural forms are communicated (Geertz, 1973, p.17).

Geertz, in effect, turns the table on cultural theory—i.e., cultural theory's function is to aid in interpretation of meaning, rather than in establishment of laws. He, however, recognizes a limitation brought to bear by a focus on presenting thick descriptions: it makes development of cultural theory more difficult. Since the purpose of a semiotic approach to culture is to grasp the Others' conceptual world in order to communicate with them, it creates an irremovable tension between the need to grasp and need to analyse in order to advance a cultural theory (Geertz, 1973, pp. 24-25).

His critics, Roger Keesing among them, however, point out that his narratives unnecessarily ignore the notion of power. For critics such as Keesing (1987), ideology is a clear example of how meaning can exert power. Ideology creates social cohesion in society, but it can also be oppressive. This criticism is about the symbolic (interpretive) approach's ignorance of the issue of power. Taking culture as text in order to find "'reverberations' of a culture in ritual, in metaphor, in meanings of everyday life" (Keesing, 1987, p. 161) is problematic.

The method of reifying cultural dimensions in order to get insights on working relationships amongst sociocultural factors found in societies should not be considered particularly problematic. One does not even have to travel all the way to Bali to witness examples of reification, not so much by the anthropologist, as by the participants in society. One need only witness some spectator sport, e.g., football, hockey, etc. to get a sense of what are really at stake in these events. Still, as said earlier, Keesing's critique is important as a reminder: culture is a complex, multi-dimensional artefact, and one must take the responsibility to figure out whether descriptions, thick or thin, amply give service to one's purposes. The outsider's view, whether articulated by a professional anthropologist or a layperson, is always incomplete. The onus to understand a

given culture's dimensions is on the outsider, rather than the participants who certainly already intuitively understand who does or knows what, and how. Clifford Geertz's symbolic model was rarely cited in the HTI literature (i.e., in two studies). Combined with other models, it should be applicable to ethnological approaches to HTI research.

2.1.4 Ecological model

In the field of anthropology, the late Marvin Harris proposed an ecology-informed theory of culture that aims to "…account for the origin, maintenance and change of the global inventory of sociocultural differences and similarities" (M. Harris, 1979, p. 27). "Culture is the socially learned ways of living found in human societies and that it embraces all aspects of social life, including both thought and behaviour" (M. Harris, 1999, p. 19). He positions cultural materialism as a scientific research strategy that is defined as a set of specific explicit guidelines.

> "By a scientific research strategy I mean an explicit set of guidelines pertaining to the epistemological status of the variables to be studied, the kinds of lawful relationships or principles that such variables probably exhibit, and the growing corpus of interrelated theories to which the strategy has thus far given rise" (M. Harris, 1979, p. 26).

Cultural materialism views adaptive human thoughts and behaviour as effects of a struggle for strategic resources. It gives priority to the study of etic behavioural infrastructure; that is, it approaches the definition of social and cultural phenomena initially but not exclusively from an etic perspective (M. Harris, 1979, p. 47). In explications of sociocultural phenomena, it gives priority to infrastructural causality, also known as "primacy of infrastructure" (M. Harris, 1999, p. 142). It views the structure of sociocultural systems in terms of the biological and psychological constants of human nature, and the distinction between thought and behaviour, and emic and etic. (M. Harris, 1979, chapter 3; M. Harris, 1999, chapter 11).

According to cultural materialism theory, the starting point of sociocultural analysis in the cultural materialism strategy is the existence of an etic human population located in etic time and space. Social nature of human groups is inferred from the density of interaction among humans found in a particular spatial and temporal locus. Culture is defined as the learned repertory of thoughts and actions exhibited by the members of social groups. These repertories are transmissible independently of genetic heredity from one generation to the next. "The cultural repertories of particular societies contribute to the continuity of the population and its social life" (M. Harris, 1979, p. 47).

The universal structure of sociocultural systems rests on the biological and psychological constants of human nature and on the distinction between thought and behaviour, and emics and etics. Each society must cope with problems of production—i.e., behaviourally satisfy minimal requirements for subsistence; hence there must be an *etic behavioural mode of production*. Each society must be-

haviourally cope with the problem of reproduction—i.e., avoid destructive increases or decreases in population size; hence there must be an *etic behavioural mode of reproduction*. Each society must cope with the necessity of maintaining secure and orderly behavioural relationships among its constituent groups and with other societies; hence there must be an *etic behavioural domestic economies* and *etic behavioural political economies*. Given the prominence of human speech acts and the importance of symbolic processes for the human psyche, one can infer the recurrence of productive behaviour leading to etic, recreational, sportive, and aesthetic products and services—i.e., *behavioural superstructure* (M. Harris, 1979, pp. 51-52).

Marvin Harris (1979) argues that ideation-centric sociocultural theories (e.g., of symbolic anthropology) applied in anthropology tend to neglect or deny salient ecological factors that better explicate cultural variables. Cultural materialism theory has not been used in human-technology interaction research. The present work submits that the theory is a useful source of materials for generating other theoretical frameworks. The theory's differentiation between etic and emic modes of research provides a basis for methods to recognize environmental and sociocultural factors that are often missed by researchers in exclusively using theories based on the epistemology of symbolic anthropology. Cultural materialism theory is relevant to the field of human-technology interaction for it offers a systems-based research strategy for finding explanations for variance in both the ideational and behavioural attributes of culture.

It has been noted that HTI research has borrowed conceptual frameworks from the field of psychology. Conceptual frameworks are often useful in situating constructs within a field of study. This also applies in situating psychology as a cultural construct. J.W. Berry and colleagues (Berry, Poortinga, Segall, & Dasen, 1992; Berry, Poortinga, Breugelmans, Chasiotis, & Sam, 2011) has proposed a conceptual framework for using classes of variables relevant to explicating similarities and differences in human behaviour and experience found across cultures (see Figure 1). The framework uses the distinction between population-level and individual level analysis with the aim of accounting for individual and group level differences as a function of population-level factors. It assumes a dialectical relationship between humans and the physical and cultural contexts they live in. This relationship can filter and alter the nature of the contexts. Inferred characteristics mean characteristics such as motives, abilities, traits and attitudes.

Biological and cultural variables, called process variables, represent transmission or influence from population variables to individuals. Ecological context means the setting in which humans and the physical environment interact. The setting is a set of relationships providing a range of life possibilities for a population. Interactivity is the essence of the ecological approach. A central feature of the ecological context is economic activity; non-industrial cultural groups are rated according to their degree of reliance on hunting, gathering, fishing, pastoralism and agriculture, while urban-industrial societies are rated according to other dimensions of economic activity. Each form of economic activity implies different kinds of relationships between the local human population and the resources of

their habitat, and these relations imply varying cultural, biological and psychological outcomes. Adaptation at the population level can be better understood across cultures when cultural and biological features of humans are taken into account. The joint interest in cultural and biological influences on behaviour provides a balanced view.

These two major sources of influence are adaptive to the contexts in which people live. Not all outcomes can be said to have been the result of ecological relationships. Cultural contact in the socio-political context of one's group also influences culture and individual behaviour, and the influences come with acculturation due to historical and contemporary experiences with colonialism, international trade, war and migration. Not all relationships between the ecological and socio-political contexts are mediated by cultural or biological adaptation. Some influences are direct and immediate—e.g. environmental learning in an ecology (leading to a new performance), nutritional deficiency during famine (leading to reduced performance), or new experiences with another culture (leading to reduced performance). (Berry et al., 1992).

By taking into account ecological, biological, cultural, and acculturation factors, one should be able to account for how and why people differ from one another, and also why they are the same. An understanding of these underlying principles also enables creation of other frameworks that aid analysis of the variability in human cognition, emotion and affect, and behaviour in relation to interacting with artefacts in general, and technology artefacts in particular.

2.2 Tacit culture

The late anthropologist Edward T. Hall observed that most of our difficulties with the notion of culture stem from our own ignorance. To date, we "…continue to fail to grasp the true significance of the fact that culture controls behaviour in deep and persisting ways, any of which are outside of awareness and therefore beyond conscious control of the individual" (Hall, 1959/1973, p. 25). Hall was speaking within the context of the United States, where he found that an anthropologist is often ignored when he or she stresses the previous point about culture. He went on to say, "…culture hides more than it reveals, and strangely enough, what it hides, it hides most effectively from its own participant" (Hall, 1959/1973, p. 30).

It seems that whoever takes on the enterprise of studying human cultures eventually encounters this paradox. People are enculturated in one or more sociocultural system, and much of the process happen more or less in an unconscious manner. Edward T. Hall's characterization of culture as something that is hidden has important implications both to people's everyday experience and to HTI.

It should have become apparent from the previous presentation on theories of culture that the construct culture has explicit and tacit dimensions. Explicit elements of culture refer for example to norms, practices, rituals, language, ideology, symbols, myths and ceremony (see e.g., M. Harris, 1979, pp. 52-54)

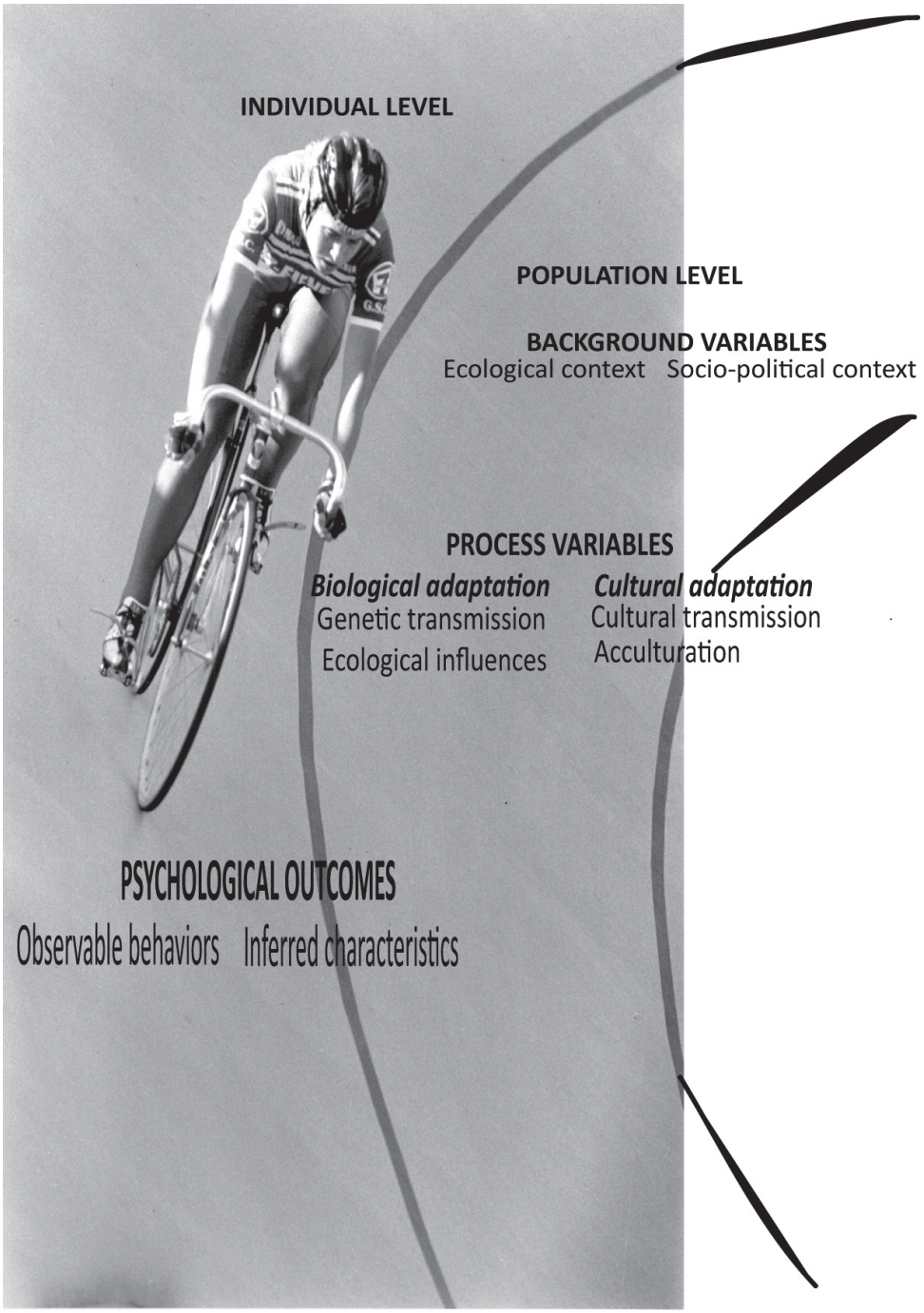

FIGURE 1 Ecocultural framework of relations among classes of variables[11].

that one would usually describe as "natural" and one can explain them by referring to some tradition that everyone knows about[12]. Holidays (holy days) and national celebrations are illustrative of explicit culture. In the Finnish context for instance, the first day of May, or Vappu (also known as May Day in other industrialized countries) marks the time of the year when people congregate at specific places to perform certain rites. Anyone who has been raised in the Finnish culture knows the significance of the celebratory activities, which include consumption of specific foods and beverages, and he or she can usually point to the Vappu traditions to explain the various observable events and behaviours taking place. There are of course variations to the details in the events and behaviours to May Day celebrations in other countries, particularly in Europe. One can also observe the similarities across cultures that have adopted the practice of parades commemorating the International Worker's Day, which has become synonymous with May Day in countries such as China.

The tacit elements of culture, on the other hand, are not readily discernable even for students of culture. Their effects are much more subtle yet nevertheless very real. A case in point is the way cultures conceptualize and embody space. Every culture handles personal and inter-personal space differently, for example the physical distance between two persons, who do not know each other well, during the course of a conversation or at the point of greeting each other. The study of proxemics reveals that in every case, the embodiment of conventions about space is unconscious, and people become aware of them only when an exception to the norm occurs. (Hall, 1959/1973).

Tacit cultural elements are difficult to make explicit because participants of a given culture are unaware of them (Hall, 1976/1981). People are unable to explain why conventions exist. They simply "know it" or "feel it" if the other person is standing too close or too far relative to what is considered as comfortable distance. The consequent effects depend on the interpretations of the participants' actions. In cross-cultural situations, effects of misunderstandings about the use of space in inter-personal interactions could range from being comical to outright frustrating.

One might be able refer to some cultural or religious tradition, but rarely could one explain how did certain ways of thinking and doing became part of a given tradition. People's behaviours and worldviews have been partly moulded through interactions with parents, other family members, teachers and other community members. Hence knowledge of culture is embedded in everyday life experiences, its artefacts and the interactions between individuals, as well as between individuals and artefacts in everyday life. Therefore, one can speak of the tacitness of culture.

The implications of culture as tacit knowledge manifest in design of artefacts as assumptions about concepts, for instance, regarding aesthetics (Kam, Mathur, Kumar, & Canny, 2009). For example one could ask why the designers of the Apple iPhone interface decided to use a representation of the interstate

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11 Adapted from Berry et al., 2011, p.14. Photo by the author.

12 Cf. "formal" mode of behaviour (Hall, 1959/1973, pp. 64-65).

highway sign to present a digital map. A plausible answer is that the designer, who sits in California and who is very familiar with the interstate highway system in the United States, could reasonably assume that most people who would use the artefact will understand the meaning of the icon. However, a follow-up investigation (Oren et al., 2009) with usability test participants in China and India did not support the assumption, and therefore the researchers recommended a redesigned interface for iPhones destined for those countries.

Going back to Edward T. Hall's observation: one can argue that much has changed since he published his findings. One can say that due to relatively rapid technological changes in areas such as human locomotion and mass media communication, people of one culture have become more aware of foreign ways of life, and therefore are not totally ignorant of what makes them both different and similar from others. The degree of understanding is of course partly a function of whether an individual actually lives through the contrasts and differences, either by living in a foreign culture, or by living in close quarters with a culture or cultures other than his or her own. One could even argue that cross-cultural interactions have always constituted human existence throughout human evolution. Conversely, one might also say that misunderstanding is more characteristic of most people's experience with cross-cultural interactions.

2.3 Critique of cultural models usage in HTI research

In the related field of instructional design, incorporating a model of culture in the design process helps designers to distinguish between generic and specialized design specifications, to internationalize or localize designs, to identify the designer's cultural biases, to minimize culture-based mistakes, to evaluate designs, and thus better meet the learning needs of the target audience (Young, 2008). Usage of cultural models in design research is still at an early stage. Cultural variables seem to be considered too abstract and thus difficult to use directly in design practice (Eugene et al., 2009, p. 22). A transformation from cultural variable to design specification is required. The use of value dimensions in the analysis of user preferences and behaviours is currently a dominant approach, but it is not yet clear whether the model adequately serves the needs of the discipline (D. P. Ford et al., 2003). Criticism of current cross-cultural information and communication technology research stems from the perceived overreliance on Hofstede's value dimension as well as from the critique aimed directly at the theory of national value dimensions.

Cultural models have been used in HTI research to establish user interface guidelines and adapt usability methods, but the technique has been criticized for leaving intact Western cultural biases embedded in information and communication technology artefacts. For example, the notion of usability is commonly equated with effectiveness, efficiency and satisfaction. Thus usability is evaluated with methods such as Think Aloud Task solving, in terms of the

number and time of task completed, but it has been noted that the criterion of task completion is irrelevant in certain cultural contexts (Winschiers-Theophilus, 2009). Suggestions such as correlating Hofstede's value dimensions with information structuring come with the assumption that effective and efficient information access is the goal of users in all cultures, but recent studies suggest otherwise (e.g., Irani et al., 2010; Winschiers & Fendler, 2007; Winschiers-Theophilus, 2009).

Concerns about the weaknesses in using Hofstede's value dimensions in cross-cultural technology design also continue to appear in the current literature. G. Ford and Kotzé (2005), for instance, set out with a hypothesis that designing user interfaces to accommodate one side of Hofstede's value dimensions (i.e., four of the five dimensions) will result in better usability regardless of users' cultural profiles, but the result of their analysis of a previous survey of 50 university students in South Africa was inconclusive. Callahan (2006) observed that whilst similarities and differences in the web design domain can be viewed in terms of the Hofstede value dimensions, the correlations between the Hofstede scores and the frequency counts of web interface elements were weaker than anticipated. Hope et al. (2007) argued that the effect of culture is contingent on the context and conceptualization of culture, as nationality may not be the most important indicator in multinational co-located settings.

Irani and colleagues argue that the national dimensions framework provides a historical view frozen in time like a still photograph. However, the framework has little to say with regard to understanding the dynamics between technologies, shifting sociocultural norms, social movements and reconfigurations of everyday rituals through technology artefacts (Irani et al., 2010).

Ford et al. (2003, p. 9) conclude that the role of Hofstede's dimensions should be at the national level and sub-cultural group level of analysis, but not at the individual level. However, Hofstede (1980/2001, p. 464) cautions about common pitfalls in doing replications, and extensions: "The dimensions were chosen so as to discriminate among national and maybe regional and ethnic cultures, but not for discriminating according to other (sub)cultural class, and organization".

Gaspay, Dardan and Legorreta (2008) observe that Hofstede's theory does not account for the effects of increased cross-border movement of people, a process that means more people are operating with at least two nationality-based cultural framework. The authors deem it unclear how the rapid movement and deployment of artefacts, particularly information and communication technology artefacts across many nations affect both values and practices of people.

Criticisms of over-reliance on Hofstede's value dimension though aimed at the way they are used in the methodology, nevertheless indirectly question the validity of the dimensions. It has been suggested that translation and transportation of culture theories from other academic disciplines to technology contexts create a perpetual loop of self-reference and self-inference rather than advance understanding (Vatrapu, 2010). Despite the concerns about validity of the value dimensions, however, they have been widely applied to cross-cultural

information and communication technology research. Other models are often linked with these dimensions (Choi et al., 2005; Eune & Lee, 2009; Heimgärtner, 2007; Mazadi, Ghasem-Aghaee, & Ören, 2008; Rincón, Boutet, Coppin, Poirier, & Curieux, 2011).

2.4 Defining culture

The theoretical perspective underlying the present work draws on elements from cultural materialism theory (M. Harris, 1999; M. Harris, 1979), open systems view in the general systems theory (Bertalanffy, 1981), cultural psychology (Cole, 1996; Markus, 1991; Markus & Kitayama, 1998; Shweder & Sullivan, 1993), and theory of embodied cognition (Varela, Thompson, & Rosch, 1991/1993). Accordingly in the present work, culture is defined as the socially learned ways of living that circumscribe all aspects of social life, including both thought and behaviour (M. Harris, 1999, p. 19) These thoughts and actions, exhibited by social groups, constitute repertories transmitted independently of genetic heritage across generations (M. Harris, 1979, p. 47). It is embedded in patterns of ideas, practices, institutions, products and artefacts (H.R. Markus and Kitayama, 2010, p. 422). It is a hierarchy of open systems maintaining itself in a steady state where autopoiesis (Maturana & Varela, 1980) hold forth. This theoretical perspective is further elaborated in the proposal for a cultural theory of human-technology interaction in chapter 5.

The working definition given above emphasizes the knowledge, practices and artefacts that constitute what one calls "culture". Culture as defined in the present work is akin to a taxonomy of human constructs, artefacts and practices. In contrast the construct *race,* although often used interchangeably with culture, is not subsumed in this definition. Race is about people. It is specifically a construct for categorizing people according to distinct physical characteristics (M. Harris, 1999, pp. 74-76). Culture is about forms of life (J. Leikas, 2009).

For example, a Chinese or an African infant raised by Finnish parents grows up speaking perfect Finnish inclusive of regional dialect; the child grows to like the local food (cf. M. Harris, 1979, pp. 124-125). Finnish children who move with or without their parents to a different culture invariably acquire the cultural repertory, the way of life of the people among whom they live.

In defining culture as taxonomy of constructs, artefacts, and practices, it includes the construct of *co-culture*, that is, a culture co-existing with another at a given level of observation (cf. non-essentialist view of culture in Holliday, Hyde, & Kullman, 2010, p. 3; groups that have culture in Matsumoto & Juang, 2008). Thus in the Finnish setting, for instance, the Swedish-speaking group, the Saame-speaking group, as well as the group classified as Gypsies constitute different cultures, which co-exist with the culture of the dominant Finnish-speaking group. One might say that this classification nevertheless includes the construct of ethnicity while at same time denies the equivalence of culture and ethnicity. The proposed definition does not deny the importance of ethnicity as

a form of classification. It is however emphasized that ethnicity, as a categorical descriptor, is inadequate in accounting for all the differences among groups of people (M. Harris, 1999, p. 75; Matsumoto & Juang, 2008, pp. 17-18).

One of the more extreme examples of a co-culture at the observation level of national borders as well as on the global level is the culture of a group of individuals with reduced biophysical capacities, or the culture of "disabled" people. As Matsumoto and Juang (2008, p. 16) point out, people with disability share with everyone else similar feelings, ways of thinking and motivation, but as a group they also share some ways of thinking and feeling that are specifically related to their impairment. Therefore to the extent that they share unique psychology, they share a unique culture.

On the one hand, it may seem obvious that people with reduced motor-sensory as well as cognitive capacities have a way of life different from those who have full use of capabilities for movement, sight, hearing and so forth; on the other hand the implications of their different culture are often overlooked (Jhangiani & Smith-Jackson, 2007, p. 512). These implications are important particularly to the design of human-technology interaction. Other instances of co-culture are the culture of aged individuals, culture based on gender roles, and culture based on sexual orientation. The main point to keep in mind regarding the definition given in the present work is that culture must be viewed from multiple levels of analysis.

To summarize: given the various definitions of culture, which are available in the literature, HTI professionals could find it challenging to operationalize the construct of culture. Operationalizing culture in terms of values and attitudes seems to be the dominant approach in projects dealing with usability issues. This seems to be a reasonable approach since related theories conceptualize culture also in terms of national value dimensions, but while a values-based approach is useful in usability studies, its validity in other types of studies is not clear. Previous reviews of the literature have indicated an over reliance on value dimensions, and have suggested an integrated approach. An integrated approach could better enable a cumulative tradition within HTI. However, synthesizing such an approach necessitates a working definition of technology as well as of the relationship between technology, culture, and human life.

3 TECHNOLOGY IN CULTURE

The aim of the present work, as previously articulated, is to contribute a research strategy for extending human-technology interaction design methods whose end products are culturally responsive concepts, user requirements, and systems requirements. The present work envisions a research strategy grounded on the principle of a co-determining relationship, which is unpacked in chapter 5, between technology, culture, and human forms of life. This enterprise necessitates further working definitions of concepts and terms employed.

3.1 Definition of terms: HTI, systems, and artefact

The usage of the term human-technology interaction in the present work broadly encompass people's usage of technology, although it is employed to specifically address some issues within the context of information and communication technology. This definition therefore subsumes human use of knowledge, which constitutes technologies, in addition to various tangible objects, and these objects can function automatically or semi-automatically as in the case of machines. Hence human-technology interaction necessarily involves physical and cognitive motion. The term "interaction" refers to the action-reaction between two or more self-contained unities; more precisely, the observable motions between a human and a technology, without presuppositions as to whether the given technology constitutes "intelligence" as often articulated in discourses regarding computerized technologies (for a more complete discussion on this point, see e.g. Suchman, 1987, pp. 5-26). Therefore even a mundane technology such as that of slicing a tomato with a knife can be described in terms of human-technology interaction. That is, the motion of the muscles sets forth another physical motion, or a *re*-action, of the knife moving through the structure of the tomato. In this respect, it also follows that using the knowledge of how to use the knife is a cognitive phenomenon.

It is important to explicitly foreground the role and position of the overall HTI process within the human context: it is supposed to support human-to-human interaction processes, inclusive of interactions with natural, institutional and societal processes (e.g., Saariluoma & Leikas, 2010, pp. 17, 20). And as will be discussed in chapter 5.2, this distinction between human-technology interaction as a process and as a component of technology interface usability concepts is of primary importance to envisioning technologies relevant to human forms of life.

The term human-technology interaction, as it is used in the present work, is compatible with the term *human factors* to the extent that both refer to the scientific discipline of designing for human use. Both constructs concern "… a body of information about human abilities, human limitations, and other human characteristics that are relevant to design" (Chapanis, 1996, p.11). However, the term human-technology interaction is used exclusively to distinguish an admittedly biased point-of-view of systems and systems design relative to the traditional point-of-view constituted in systems engineering. The emphasis is on humans and human factors as the starting point for systems design.

The term *system* is defined as "… an interacting combination, at any level of complexity, of people, materials, tools, machines, software, facilities, and procedures designed to work together for some common purpose" (Chapanis, 1996, p. 22). Emphasis is also given to the human-centric view of systems and system design while acknowledging this view must be integrated with the architectural and functional views in order to fully describe the requirements for a given system, and eventually producing it embodied in an artefact used by people. The term *artefact* subsumes material and immaterial objects and subjects pertaining to human interaction with technology.

3.2 Defining technology: a cultural artefact

What is technology? The present work adopts José Ortega y Gasset's definition: "…[T]echnology is man's reaction to nature or circumstance. It leads to the construction of a new nature, a supernature interposed between man and original nature" (Ortega y Gasset, 1972/1983, p. 292). What one calls technology is therefore a product of interaction between humans and environments in which they are situated. This implies that technology is a reaction to the necessities of life. However, one can see that this is not necessarily true when one considers the nearly daily encounters in contemporary life with cultural artefacts such as books, television, movies and digital games. Ortega y Gasset's insight is also instructive:

> "But technology is not restricted to the satisfaction of necessities. As old as the invention of tools and procedures for keeping warm, feeding, and so on, are many others serving to procure obviously unnecessary objects and situations. As old and as widespread as the act of lighting a fire, for instance, is that of getting drunk. I mean to say the use of substances and procedures, which produce a psychophysical state of

> pleasurable exaltation or delightful stupor. The drug is as primitive an invention as any. So much so, in fact, that it is even open to discussion whether fire was invented primarily for the purpose of avoiding the cold—an organic necessity and a *sine qua non* [emphasis in original] of life—or of getting drunk. We know of primitive tribes who light a fire in a cave which makes them sweat so profusely that, from the combined smoke and excessive heat, they fall into a swoon akin to drunkenness. These are the so-called sweathouses"[13] (Ortega y Gasset, 1972/1983, p. 293).

Four points deserve emphasis: first, there is inherent ambiguity in the relationship between the form and function of what Ortega y Gasset calls the constructed "new nature"; that is, a new artefact that interposes between humans and nature. The second point is that the new artefact—i.e., technology, has both tangible and intangible form. The technology of lighting a fire consists of tangible objects as well as knowledge of at least the procedure involved. Acknowledging this ambiguity helps to understand the possibilities for variations in the meaning of technology, meaning that affects usage, meaning that gets passed on from one generation to the next. Third, throughout history technology has been envisioned in various ways to solve problems encountered during people's interaction with nature and circumstances. Fourth, technology is a product of a creative process and people can use it creatively. Hence the given definition allows us to analytically think of technology's material/immaterial, semantic, and functional dimensions. This is the rationale for adopting Orgeta y Gasset's definition.

For contrast, Mario Bunge provides a less philosophically inclined definition, though it echoes the fourth point emphasized above: "In fact we conceive of technology as the *design of things or processes of possible practical value to some individuals or groups with the help of knowledge gained in basic or applied research* [emphasis in the original]. The things and processes in question need not be physical or chemical: they can also be biological or social" (Bunge, 1988, p. 604).

Many mundane objects and situated actions in daily life, from cooking a meal to driving an automobile, can take on universal as well as varied form and meaning. In contemporary daily life, new technologies such as, mobile telephones, text messaging, social media, and instant messaging (De Angeli, 2009; H. Li et al., 2011; Rangaswamy & Singh, 2009; Sun, 2007) are subject to this phenomenon.

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13 The quote is from a revised translation. The original text is as follows:
"Pero es el caso que la técnica no se reduce a facilitar la satisfacción de necesidades de ese género. Tan antiguos como los inventos de utensilios y procedimientos para calentarse, alimentarse, etcétera, son muchos otros cuya finalidad consiste en proporcionar al hombre cosas y situaciones innecesarias en ese sentido. Por ejemplo, tan viejo y tan extendido como el hacer fuego es el embriagarse…—quiero decir, el uso de procedimientos o sustancias que ponen al hombre en estado psicofisiológico de exaltación deliciosa o bien de delicioso estupor. La droga, el estupefaciente, es un invento tan primitivo como el que más. Tanto, que no es cosa clara, por ejemplo, si el fuego se inventó primero para evitar el frío—necesidad orgánica y condición *sine qua non*—o más bien para embriagarse. Los pueblos mas primitivos usan las cuevas para encender en ellas fuego y ponerse a sudar en forma tal que entre el humo y el exceso de temperatura caen en trance de cuasi embriaguez. Es lo que se ha llamado las "casas de sudar" (Ortega y Gasset, 1939).

It has been said earlier that unexamined assumptions about concepts used in human-technology interaction design have proven to be problematic. One can say that this problem can be traced to the tacit status of technology's relation to culture. The connection could be made more obvious with a simple thought exercise by examining many mundane artefacts of daily life such as food and time.

Humans are the only known animal species that cook its food. Foods that people eat, when and how they are eaten are components of every culture. Imagine what would happen to the food cultures of the world if one takes away the technology of cooking with heat. With regard to the idea of culture as rituals and traditions, for example rituals and traditions supporting concepts of time (see e.g., Hall, 1959/1973), imagine what would happen to rituals of making appointments for lunch, or to meet with a friend to see a film or to meet a client to discuss business, if one did not have the technologies embedded in timepieces like clocks and wristwatches. Similarly imagine the types of adjustment one would have to make to the whole English culture and the history of the English empire, if chronometers were never developed in the eighteenth century for maritime navigation in conjunction with establishing Greenwich as the starting point for measuring "accurate" time. And similarly one cannot deny the significance of European shipbuilding, navigation and their underlying technologies (Larson, 2011; Sorrenson, 1996).

Consider the so-called exterior single-leaf hinged door that one uses for entering residential buildings (e.g. houses and apartments). Doors and their function are things that one usually considers as obvious. People enter and exit houses, apartments, as well as various types of building without much thought about them. But consider the following: in some countries (e.g. Finland and Sweden) the majority of home's exterior single-leaf hinged doors open outward, while in other countries (e.g. Spain, United Kingdom, United States) these types of doors swing inward (cf. discussion of doors in Norman, 2002).

From the perspective of human-technology interaction, the architecture of thresholds (i.e. doors, gates, portals and passageways) in connection with the architecture of structures and the traditional function of a private home as a space for residence, sojourn and interaction, presents an exemplary artefact that one can study to help shed light on the issues at hand.

The daily action of entering and exiting various types of spaces, such as bedrooms, bathrooms and boardrooms, is a microcosm of human interaction with an *interface*: the door. This view could help in conceptualizing how a mundane object such as a door is actually a technology with a long history of development throughout the evolution of human cultures.

The form/function of the door compels one to speak of *separateness* and *unity* (cf. Simmel, 1994). Viewing the threshold on the physical level, architectural theorist Laurent Stalder aptly comments, "The threshold separates the public and private sphere, private and common property, and self-determined and over-directed action. As an architectural element or spatial configuration, it highlights *historically specific, culturally determined zones of transition* [emphasis

added], in which certain gestures and activities are performed" (Stalder, 2009, p. 69). Stalder also characterizes the door as a point of transition. Georg Simmel addresses these transitional movements at the physical and metaphysical levels in his essay about bridges and doors. He provides important insights on this circularity:

> "Whereas in the correlation of separatedness and unity, the bridge always allows the accent to fall on the latter, and at the same time overcomes the separation of its anchor points that make them visible and measurable, the door represents in a more decisive manner how *separating and connecting are only two sides of precisely the same act*. [emphasis added]. The human being who first erected a hut, like the first road builder, revealed the *specifically human capacity over against nature, in so far as he or she cut a portion out of the continuity and infinity of space and arranged this into a particular unity* [emphasis added] in accordance with a *single* [emphasis in the original] meaning. A piece of space was thereby brought together and separated from the whole remaining world. By virtue of the fact that the door forms, as it were, a linkage between the space of human beings and everything that remains outside it, *it transcends the separation between the inner and outer*. [emphasis added]. Precisely because it can be opened, *the closure provides the feeling of a stronger isolation against everything outside this space than the mere unstructured walls*. [emphasis added]. The latter is mute, but the door speaks. It is absolutely essential for humanity that it sets itself a boundary, but with freedom, that is, in such a way that it can also remove this boundary again, that it can place itself outside it" (Simmel, 1994, p. 7).

Simmel's (1994) metaphors articulate the circularity of interaction between humans and the environment. The acts of separation and unification are co-determined in the door. Applying this circularity to Stalder's (2009) observation, culturally determined transitions allow a further assertion that technology and culture are co-determined and therefore cannot be separated. The historical account of the door further shows that this mutual determination has been embodied concurrently within cultures and the artefact of the door itself, and passed on from generation to generation all the way to contemporary daily life. The cultural meaning of the door has dissolved into the background to the point that laypersons would have to expend much effort to articulate the door's connection to their culture, literally or metaphorically.

While the history of threshold technology goes back to ancient times, and thus has had ample time to recede into the realm of tacit knowledge, one can say that the cultural meanings of contemporary artefacts such as computers and their software programs have already reached a similar tacit status especially among the generations who were "born digital" (that is, those born after the advent and diffusion of the digital computer and related technologies). For instance in the U.S., young adults of the so-called millennial generation (that is, people born 1977-1993) tend to use their mobile phones for more purposes (i.e., taking photos and videos, sending text messages, going online, sending email, listening to music, and playing games) compared to their counterparts from older generations (Zickuhr, 2011). Fifty-three per cent of adults aged 65 or older are using Internet or email. The latest data (April 2012) on the number of Internet users from this cohort is significant in view of the modest growth for several years (Zickuhr & Madden, 2012). It is interesting to note also that another archi-

tectural component—a window—has become a trademark as well as the metaphor for the interface between material and immaterial spaces of computing.

In light of the preceding examples, one is confronted with the issue of different usage in different cultural contexts of technologies that have become diffused, prevalent in daily life, and more or less standardized. There are logical reasons for the differences, and many of these reasons are linked to cultural characteristics.

Culture and technology are inseparable, not even in principle[14] . There is no technology-free culture. Separating the two would necessitate undoing human cultures. Certainly contemporary cultures in all parts of the world would not be the same if electricity, automobiles, telephones, airplanes, nuclear energy, television and computers did not exist. One could safely argue that if all the computers in our world vanished suddenly, contemporary civilization would fall into a chaotic state.

At this point, there has to be a differentiation between the view of culture and technology presented here from the notion of technological determinism; that is, the idea that technology is a predominant determinant of social life, and that technology develops autonomously (Mitcham & Nissenbaum, 1998). Although there is agreement with José Ortega y Gasset's (1939/2006; 1972/1983) argument that human beings are essentially technological and that history is transformed by changes in technology, the view proposed in this work asserts that the relationship between culture and technology is one of co-determination or co-specification. Whilst changes in technology cause changes in the practices and ideas of a culture, changes in a culture's characteristics could similarly trigger changes in technology.

Once the co-determination of culture and technology is acknowledged, one could also begin to see how technology artefacts used in daily life might trigger variations in sociocultural conventions.

3.2.1 Technopolitics

The idea that technical things have political qualities is perhaps one of the more esoteric if not provocative notions in the discussion of technology's functions in societies. Much of the rhetoric, if one even becomes aware of it, is based on tacit assumptions. Most people would not notice it. The news media for example published stories of the trouble the company Google had with the German authorities regarding its project to photograph practically every meter of German cities in connection with the company's map service (Bilton, 2013; Kirk, 2010). Google employees driving around in cars equipped with 360-degree view cameras apparently managed to gather a database of residential wireless network access information. The issue of privacy invasion was implied (Rakower, 2011; Wiggers, 2011). Yet in major metropolitan areas, the presence of surveillance video cameras is ubiquitous in street corners, and in practically all the nooks and crannies of the city. Most people probably do not think much about the im-

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14 Cf. technoculture as semiosis (Vannini, Hodson, & Vannini, 2009, pp. 469-473).

plications of surveillance activities (Goold, Loader, & Thumala, 2013). One is made more aware of surveillance technology's utility to the collective well-being, as for example in the way the police were able to narrow the list of suspects for the bombing during the Boston City Marathon in 2013 in the U.S. through their database of videos gathered from cameras situated in the immediate vicinity of the event (Atlas & Stohr, 2013; Kelly, 2013). On a more mundane level, one neither pays much attention to how various information and communication technologies silently and automatically keep track of one's movement, of the products one buys, and of how much money one spends (Caviglione & Coccoli, 2011; Langenderfer & Miyazaki, 2009; Ybarra, 2011).

Where is the politics? The simplified answer is everywhere. In discussing technology's political dimension, one must acknowledge how the meanings of technologies are socioculturally constructed (Bloomfield & Vurdubakis, 1994; Feng, 2000; Winner, 1992). Introduction of technology in contemporary human domains of action is rationalized, for instance, in terms of its utility in increasing efficiency.

The sociocultural semantic engineering of technologies could be intentional, non-intentional, or emergent. The salient point is that as an observer, one has an accustomed way of looking at things, and one sees the details of the form and function of artefacts as innocuous. But it is not always so. Langdon Winner (1980) explains for instance that the two-hundred overpasses in Long Island, New York were originally designed to discourage buses on the motorways of Long Island, thereby giving an advantage to automobile owning European Americans of the upper- and middle-classes to use them for commuting and recreation, while sanctioning poor people, particularly African Americans who normally used public transit. They were kept off the motorways because the tall buses could not drive through the low-hanging overpasses. One consequence was to limit access of racial minorities and poor people to Jones Beach.

Nuclear power plants and nuclear weapons are examples of inherently political technologies. These artefacts entail explicit control by designated authorities. One can also observe the intended, unintended and emergent political dimensions of information and communication technology artefacts such as computers and mobile phones within national boundaries as well as globally. One can see recent examples of the power dynamics of technology in the U.S. National Security Agency's activities to tap into electronic mail data on a global scale (Hopkins, 2013; Miron, 2013), and in the blocking of social media applications in Iran and Egypt (Tusa, 2013; Wojcieszak & Smith, 2013), and of Internet search in China (S. W. Kim & Douai, 2012).

Consider the growing gap along the socioeconomic divide as an unintentional consequence of the introduction of computers in societies (Hargittai, 2008), or the role of mobile technology in the political economy, as for instance its use during the mass political uprising in the Philippines (Pertierra, 2002). The theory of technological politics offers a framework through which one can begin to interpret and explain some of the puzzling patterns manifesting around us.

To sum up: thus far the presentation on the import of culture to human experience has aimed at establishing the interdependency of culture and technology. Technology and technological change are vital to the evolution of culture. People have developed stone tools, bows and arrows, digging sticks, ploughs, agriculture, ceramics, wheels, machinery, computers, telecommunications, bio- and nanotechnologies. These inventions have assumed a material social existence. They have also influenced survival and reproduction. One cannot fully disengage technology from human culture without having to undo much of human history.

One can say that contemporary human existence, especially in urban areas, is highly dependent on technology and technology-supported practices. People who live in highly industrialized habitats take for granted much of the technologies that surround them. They become acutely aware primarily through breakdowns in the techno-environmental infrastructure, for example through disruptions in the electrical power grid and in the distribution of subsistence materials. In contrast, daily life in less industrialized habitats is characterized not only by disruptions but also by outright failure of the techno-environmental system to provide subsistence materials to millions of people.

Culture and technology are artefacts intimately intertwined in the continuous history of human experience. Cultures at the band level of development that subsisted (still subsist) through the practice of foraging, as it is known ethnographically, could not have diffused without the development of technologies such as bows and arrows, kayaks, blowguns, stone and bone tools (Henrich & McElreath, 2003, p. 124). Cultures at the level of tropical forest slash-and-burn farming villages needed the technology of creating fire; Neolithic mixed dry-farming villages required agricultural technologies; the amplification of pristine states of Mesopotamia, China, India, Peru, and Mesoamerica required hydraulic technologies in conjunction with irrigation agriculture (M. Harris, 1979, pp. 101-102).

If one accepts the notion of a planetary culture whose characteristic includes noetic participation on a global scale (e.g., Jenkins, 2006; Thompson, 2007), then one has to acknowledge the role of computer-mediated technologies. Hence technology has developed as a by-product of human coupling with the environment, and the use of technology has become a means of intervention that transcends and modifies constraints. Technology and related practices have been developed to gain a degree of control over rates of subsistence production, especially the production of food and other forms of energy; technology and related practices have been developed for expanding, limiting, and maintaining population size (M. Harris, 1979). And from modernity onwards, it is clear that advances of technologies paralleling developments in mathematics, physics, computer science, neuroscience, cognitive science, biology and nanoscience are accelerating human intervention to the planetary ecosystem and shaping cultures at all levels.

4 CULTURE IN HTI: CURRENT APPROACHES

Situating this work's themes and propositions into a current perspective necessitates a summary of recent developments in HTI research. This chapter provides a non-exhaustive summary. Leikas (2009, pp. 36-66) provides a comprehensive review of contemporary human-centric, or "user-centric" design approaches including ethical design, value sensitive design, worth-centred development, inclusive design and gerontechnology, and emphatic design. The following exposition adds to this review beginning with the most widely practiced approaches.

It has been suggested that the notion of integrating culture into the design of technology artefacts is a relatively new addition to the agenda of HTI researchers and designers. There seems to be a growing realization of the need for more empirical studies to fill the gaps in the literature to aid a deeper understanding of cultural effects on the design of artefacts. It is possible that we are still at the stage of paradigm development when design practice has to be first deconstructed to get a deeper understanding of its methods in relation to the current dynamics between socioculturally determined behaviour and ideas, and technology use. Indeed, current research work on human-technology interaction methodology deconstructs established theories and practices to propose alternative research and design strategies.

Several research strategies, applicable either to particular domains of action or to general purposes, have been proposed. Reviews of current HTI literature support the drive for realigning artefacts to achieve cultural fit. Research seems to be shifting away from traditional usability methodology moving toward proposals of holistic approaches, seeking alternative cultural theories as basis for examining the effects of cultural factors on the design of artefacts, and deploying culture-related research much earlier in the design process (e.g., a specific artefact has not yet been produced prior to deployment of a study). The following sections present research frameworks that have been proposed both for domain specific and general application.

4.1 Human factors in ergonomics

Professional practitioners often use the terms human factors and ergonomics synonymously. While there are subtle differences in the definitions of the two concepts, they are both concerned with designing to accommodate people (Chapanis, 1996). Human-technology interaction, as "work" has been viewed traditionally from the perspective of systems engineering. This implies that while the discipline of human factors in ergonomics (HFE) aims to ensure the well-being of workers, this state of being is ultimately a means to an efficiently functioning system. Human factors are thus subsumed into the description of the system. Depending on the type of system being developed and the systems designer/engineer's appreciation and acceptance of human factors, people may or may not be situated in the centre of the design process. This should not come as a surprise when one traces the lineage of the ergonomics concept to the work of Polish scientist W. B. Jastrzebowski who original proposed and defined the concept in 1857 (Karwowski, 2012); that is, at the later stage of the Industrial Revolution. One can see the dynamics of machines serving humans versus humans serving machines in the objectives set up for the HFE discipline (Table 2).

TABLE 2 Objectives of human factors ergonomics (HFE).[15]

Objectives for affecting users and operators	Improve the working environment; reduce fatigue and physical stress; increase human comfort; reduce boredom and monotony; increase ease of use; increase user acceptance; increase aesthetic appearance.
Operational objectives	Reduce errors; increase safety; improve system performance.
Reliability, maintainability, and availability, and integrated logistic support	Increase reliability; improve maintainability; reduce personnel requirements; reduce training requirements.
Other objectives	Reduce losses of time and equipment; increase economy of production.

One could say that contemporary HFE practices are accumulated in theories and practices aiming to ensure that human requirements are not forgotten during the systems engineering process. It arguably contributes to the well-being of people who use a given system.

In contrast to system design targeting highly selected or skilled people (e.g., airplane pilots, nuclear power plant operators), design of systems such as telephones, DVD players and personal computers for general use precludes the assumption that the users will be selected in any particular way or will receive any training at all. Cultural human-technology interaction design and a sub-

15 Adapted from Chapanis 1996, p. 16.

discipline known as cultural ergonomics (Kaplan, 2004) primarily target this type of systems design.

4.2 Usability research

Current usability research evaluates design-relevant attributes for potential correlations with cultural values (Clemmensen & Roese, 2010). Cross-cultural studies tend to focus on variance in known value dimensions in Eastern versus Western cultures. The dominant approach is to study the correlations between value dimensions, particularly Hofstede's value dimensions (G. H. Hofstede, 1980/2001), and interface design-relevant preferences, as well as content. Researchers seem to recognise the potential effects of cultural factors on usage behaviour, the need for employing cultural models in the research and design processes, and the weaknesses in using the Hofstede value dimensions as well as the general weaknesses of the realignment research strategy. However, beyond the shared goal of improving usability, researchers diverge in their methods and approaches. They have examined the relationships of cultural factors, communication styles, and cognitive styles. Cross-cultural studies often demonstrate differences in preferences, but the more difficult task of interpreting the meaning of these differences is compounded by the eclectic nature of the approaches used. Information and communication technology design-related issues regarding values, norms, attitudes, communication style and cognitive style can be better understood and potentially resolved by examining similarities and differences in the affordances and constraints provided by culture.

4.2.1 Values, norms and attitudes

Usability problems pertaining to information and communication technology artefacts or any artefact primarily stem from misunderstandings between people, and these misunderstandings are by-products of misaligned communication about the conceptual model underlying artefacts. People form conceptual or mental models (D. Gentner & D. R. Gentner, 1983; Kempton, 1987; Norman, 2002) about an artefact by interpreting its perceived function and visible structure. At least two people stand on opposite sides of this visible structure. On one side is the designer who communicates his or her mental models of how and why a given artefact works through its design. On the other side are people who develop their own conceptual models through interactions with the visible structure.

Norman (2002, p. 16) points out that there are actually three different conceptual models at play: the design model (i.e., the designer's conceptual model), the user's model, and the system image resulting from the physical structure as well as the documentation, instructions and label accompanying the artefact. Usability problems arise because the designer expects the user's model to be

identical to the design model, but the designer does not directly talk to the user. All communication takes place through the system image (i.e., the artefact). If the system image does not make the design model clear and consistent, the user ends up having the wrong mental model. There are two points to consider about this communication: first, it is inherently prone to misalignment due to the lack of a direct link, inclusive of a feedback loop, between the two parties; second, the process of forming conceptual models is inclusive of people's beliefs, attitudes and values. Since people from different cultures often follow different norms and vary in their beliefs, attitudes and values, this second point tend to compound communication problems, which in turn manifest as usability problems. Hence, usability researchers tend to tackle cultural usability problems by mapping cultural variables to the design model and system image.

It has been earlier indicated that using cultural models to differentiate values, norms and attitudes is the prominent research strategy in cross-cultural usability. A practical reason is that models such as Hofstede's value dimensions readily provide indices that can be correlated with usage preferences and behaviour across cultures. But one has to be aware of some issues about value dimensions when applying it to design.

In the domain of artificial intelligence (AI) research, for example, cross-cultural theory and psychological theories have been combined in order to create an emergent affective model that can be used in designing synthetic agents, which display culturally influenced human personality properties in their communication (Nazir, Enz, Lim, Aylett, & Cawsey, 2009). Nazir et al. (2009) linked Hofstede's value dimensions, Psi model of emotions (Bartl & Dörner, 1998) and the Big-Five model of personality (e.g., Goldberg, 1992) to model computational synthetic characters. The researchers used Hofstede's value dimensions to define cultural parameters, which describe the cultural personality in a synthetic agent, and incorporated the Psi and Big-Five personality factors to formalize the agent's decision-making and actions. They concluded that culture and personality increase the believability of synthetic characters and also affects the characters' perception of the world[16].

Alternative approaches have been proposed. Reinecke and Bernstein (2007) suggested using the notion of stereotypes and communities for an initial classification of users groups, and combining these classifications with artificial intelligence (AI) techniques to automate gathering of culturally related data on individual users. The resulting data provide input for automatically creating a user model, which in turn serves to realign a software program's user interface appropriately to a target cultural frame. The authors suggested employing existing AI techniques such as user modelling shell systems, machine learning techniques, and interaction history method to ascertain user modelling information, and hence to avoid a separate manual acquisition.

Siu-Tsen Shen, Martin Woolley, and Stephen Prior examined the design implications of macro-level sociocultural phenomenon of globalization together

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16 See also work on cultural software by Mazadi and colleagues (Mazadi, Ghasem-Aghaee, & Ören, 2008).

with related human-computer interaction processes of internationalization, localization, glocalisation, iconisation, and culturalisation in order to outline a "culture-centred design" process (S. Shen, Woolley, & Prior, 2006). They identified culture-centric metaphors for user interfaces as a possible solution to the cultural realignment problems. "[A] good user interface is dependent on an effective metaphor that echoes the user's conceptual model and enhances human-computer interactions" (S. Shen et al., 2006, p. 827). In addition to culturally appropriate metaphors, they identified other design related factors such as information visualization based on understanding of semiotics, aesthetics, navigational flow (i.e., direction of visual scanning), and user experience, all of which have impact on whether user interface design is successful, i.e., in supporting users according to their contextual environment and purposes. They set out to realign the desktop metaphor employed in personal computers by creating a garden metaphor, which they claimed to be more compatible with the Chinese sociocultural context, and to have good potential for adaptability into other cultures. Their approach involved an iterative heuristic evaluation of designs, for which assumptions are based on the designer's own experiences and knowledge of the target culture, and on surveys of test participants' preferences and interactive performance with the provisional user interface.

In contrast to the cross-cultural approach, Kim and Shade (2007) employed diverse practice-based approaches in studying cultural influences on publishing software products within a single culture, while examining the needs of people belonging to cohorts that arguably have different culture. The researchers employed longitudinal studies involving a focus group in Japan (i.e., professional designers working for printing businesses) whose members provided feedback in the early stages of an iterative interface design process. For their study of a second target group characterized as non-professional users or consumers, the researchers used participant interviews combined with collection of cultural artefacts from stores frequented by members of the target group in order to take a "…broad look at the means and meanings behind how users keep and archive their memories" (H. Kim & Shade, 2007, p. 113). Although focused on the Japanese culture, this research included a cross-cultural dimension. The researchers set out to uncover cultural differences in how similar holidays or traditions are observed in Japan compared to the United States to guide U.S. based designers who have the task of creating culturally aligned content for the Japanese market. The authors concluded that there is no standard approach to designing culturally relevant software.

4.2.2 Anthropometry

The study of body size and associated characteristics—anthropometry, refers to measurements of body size, and shape. Anthropometry data on people from different nationalities can be used in the design process. There are various databases providing anthropometric data (derived from one-dimensional measurements and three-dimensional body scanning). Knowing the target user pop-

ulation is the first step to determining which database will be applicable. One will find variations among groups within national borders as well among groups across different countries. The population of the United States for instance is a composite of people of many different races and ethnic origins. Even in populations assumed to be relatively homogenous, the population in Finland for example, the researcher must pay attention to effects of composite trends particularly for groups living in urban areas.

Anthropometric measurements including those in databases or anthropometric models should be considered as approximate, and treated only as a starting point for gathering required project specific data. Measures can differ greatly depending on the size and composition of the target group that was measured, the measurement tools used, and the skill of the measurers in precisely locating body landmarks. Using and interpreting anthropometric data require particular attention to differences between females and males, differences among ethnic and national groups, and differences among different age cohorts. One must also keep in mind that human body dimensions changes over time. For example Roebuck, Smith and Raggio (1988, p. 35-36) found evidence for a trend of overall growth in stature among Japanese and European populations of approximately one centimetre per decade during the period 1890 to 1970.

More recent studies in secular trends in growth also have noticed similar trends during recent decades, with increases in adult body stature varying between 0.3 and 3.0 centimetres per decade. Secular changes in growth and development can be defined as the changing pattern of somatic development of children in a particular population from one generation to the next. These changes result from the combined effect of changes in the overall body size, and changes in the period of time required for growth to adult stature. (Hauspie, Vercauteren, & Susanne, 2008).

A corollary to these trends however is that they are not fully understood; socioeconomic, dietary, clinical, and psychological, genetic and environmental factors have been proposed as explanations (Bogin, Smith, Orden, Varela Silva, & Loucky, 2002; Bralic, 2011; Kagawa, 2011). The most salient point for human-technology interaction research is that these temporal changes must be taken into account as appropriate. These changes are of little importance to many products expected to have a short life cycle; they must not be ignored however for systems such as aircraft, power plants, and large land and sea-going transports (e.g. train, ships, spacecraft), which have life cycles extending several decades (Chapanis, 1996).

It has been proposed that secular changes in growth should be considered as indicators of socioeconomic and socio-hygienic conditions, and of a population's state of health (van Wieringen, 1986 as cited by Hauspie et al., 2008). Hence changes in factors reflecting the overall health status of a population should be expected to have an effect of secular trends. If one accepts this proposal, it follows that cultural factors have an indirect effect on anthropometric data, for culture partly determines socio-economic and socio-hygienic condi-

tions as well as a population's overall state of well-being. Another way in which culture has affect on anthropometric measurements is seen through the effects of clothing on human-technology interaction. Culture inclusive of ecological factors determines the type of daily clothing worn by groups in various environments.

Chapanis (1996) explains that most anthropometric measurements are made on nude or nearly nude persons. In work domains for instance, people rarely operate machinery with no clothes on. Work clothes and clothing worn by people in certain extreme environments as in the artic regions increase some body dimensions, or in certain scenarios constrain the human-technology interaction.

There are significant anthropometric differences among various ethnic groups. They vary in height and in body proportions. Germans for example are relatively more long-legged as measured by the ratio of leg length to stature, than most other ethnic groups, whereas Japanese people are relatively short-legged (Chapanis, 1996); ethnic Finns originating from north-central Finland are relatively large and broad-bodied (Ruff, Niskanen, Junno, & Jamison, 2005).

It should be obvious that these differences must be taken into account in the design of products manufactured for worldwide distribution. Automobiles, computer workstations, bicycles, home furniture, seats and other equipment for buses, train, and aircraft designed for exclusive use in Japan or other Asian countries have to be designed to different proportions than those designed exclusively for Finland.

4.2.3 Domain applications

Investigators reporting on their quantitative research have adopted cultural models to culturally contextualize ICT-related domains. Suadamara, Werner, and Hunger (2011) investigated how culture influences users' preferences and behaviour in the domain of groupware applications—i.e., technology designed to support the work of groups. The authors used Hofstede's value dimensions to extend the Technology Acceptance Model (Davis, 1989) and to look for differences in preferences and behaviour of over 500 survey participants from Indonesia, Malaysia and Germany.

Heimgärtner emphasized the need for creating hypotheses and testing the relationships between information processing and culture, and hence created the "Intercultural Interaction Analysis (IIA)" tool (Heimgärtner, 2007, p.89) to capture data on HCI in the domain of automotive navigation systems. The author reported using existing metrics, and developing new metrics to measure cross-cultural HCI. Heimgärtner (2007, p. 90) identified 118 culturally sensitive parameters and implemented them into the Intercultural Interaction Analysis tool, which was used to look for differences in cultural behaviour amongst test participants with Chinese or German cultural backgrounds. The tool was used to test some of the interrelationships between culture and information processing through measurement of numerical values such as information speed,

information density, information context, and interaction speed relative to the user. These measures were "hypothetically correlated to cultural variables concerning the surface level like number or position of pictures in the layout or affecting the interaction level such as frequency of voice guidance" (Heimgärtner, 2007, p. 91). Heimgärtner applied the Hofstede value dimensions to a questionnaire, which was used to determine value dimensions characterizing test participants' cultural behaviour.

Choi, Lee, Kim, and Jeon (2005) interviewed a total of 24 participants in Korea, Japan, and Finland in a study of cultural influences on mobile data services design. Study participants viewed videos of using mobile data services, which are popular in all three countries (i.e., downloading ring tones, downloading games, reserving movie tickets, and reading sport news). Participants first viewed a video of the actual usage processes as they are done in their respective country, and afterward viewed video clips of the processes as they are done in the other two countries. The researchers then interviewed the participants by using open-ended questions concerning impressions of the videos and about preferences. They elicited from the interview data 52 attributes deemed to be relevant to the design of mobile data services. All participants mentioned "minimal steps or keystrokes" (Choi et al., 2005, p. 665) as a salient feature of the service, hence the authors suggested it could be generalized to all three countries. As for the other ten attributes, the authors used assumptions based on Hofstede's as well as Hall's cultural models in order to explicate the observed variance in participants' preferences. Designers of mobile data services can use the fifty-two attributes to develop new services for the countries in the study.

Street interviews in large cities coupled with observations featured prominently in the methodology used by Yanqui Cui, Jan Chipcase, and Fumiko Ichikawa (Cui et al., 2007). The researchers studied mobile phone carrying behaviour at eleven cities in nine countries in order to identify how carrying options affected the over-all user experience in using mobile phones. They observed culture-related variance in how and where people carried their mobile phones, as well as in how people personalized the appearance of their phones. The authors considered several approaches to explicating the observed variance in behaviour—Hofstede's individualism-collectivism value dimension, socio-environmental examination, design culture evolution, and economic development. They inferred that mobile phone carrying options taken by users could negatively impact their ability to notice calls and other incoming communication. Hence carrying options constitute an important design-relevant attribute.

4.2.4 Representations and unexamined assumptions

Criticisms of the internationalization-localization process have been alluded to in chapter 1. Bourges-Waldegg & Scrivener (1998) argue that the "culturalisation" process' is inadequate in assisting designers and developers to create more usable information and communication technology artefacts, for the em-

phasis on finding cultural differences, and creating guidelines and design rules has taken attention away from the more salient point of understanding the causes of usability problems. Cultural usability, as a successor to the internationalization-localization process seems to suffer from the legacy of its predecessor. There have been two proposed approaches for dealing with this challenge. One approach in effect sidesteps the issue of finding cultural variables, while another proposes a deeper awareness of the Western biases embedded in the usability evaluation methods and calls for adapting the concept of "usability" to each cultural context, in which the researcher is involved.

4.2.4.1 Shared context and representation

Bourges-Waldegg and Scrivener (1998) point out that the problem in designing interfaces for culturally diverse audiences is fundamentally a problem of communicating the intended meaning of representations. Culturally determined usability problems stem from how the representations, which are used within an artefact, mediate the actions of users. Indeed, one can argue that differences between cultures are fundamentally representational differences. That is, cultures differ partly because their systems of representation differ. This observation implies that usability problems manifest because in order to communicate the functions of an artefact, a designer must use metaphors and other representations whose meanings might be deeply rooted to a specific cultural concept. On the other side of the communication, the user's understanding of a representation might be influenced also by culture-specific contexts. Hence, to understand the intended meaning, the user has to share the context in which the representation is rooted; otherwise, the intended meaning is misunderstood, eventually preventing the user from realizing the intended benefit of the represented function. (Bourges-Waldegg & Scrivener, 1998).

Different systems of representation as a basis of cultural differences does not necessarily mean that a person from one culture will not be able to understand a representation from another culture. Understanding representations means understanding that "…R (Representation) means M (Meaning) in *Context C*" [emphasis added] (Bourges-Waldegg & Scrivener, 1998, p. 300).

Most cultural usability research assume that people from different culture cannot share a context, but this stance becomes problematic from the perspective of intercultural communication and general interchange of tangible as well intangible artefacts (Bourges-Waldegg & Scriver, 1998, p. 300). For example, people from different cultures share a popular music culture, a manga culture, a car culture, a mobile phone culture, an Internet culture, and so forth. Therefore, a more important question to ask is whether, for instance, two persons share contexts in order create representations that have equivalent meanings for both.

A counter-argument underlines the futility of accounting for cultural specificity of representation. This line of argument says people learn quickly and are able to associate functions with representations without knowledge of the context in which the meaning is rooted. It has been observed, however, that if a person does not understand the representation, it is more difficult for her or him to learn the represented function. The failure to learn the function might

stem from fear of negative consequences of interacting with something that is not understood.

Language related problems are often assumed to be a main contributing factor to cross-cultural usability problems, but given that language is a representational system, language related problems could be generalized as that of understanding the meaning of representations. Intercultural communication between users might be a less problematic issue from the perspective of designers because people are able to jointly develop a communication space despite differences in culture and language, and therefore through this person-to-person interaction, they are able to explain and negotiate the intended meaning. It is also often assumed that people prefer ICT artefacts translated in their native language. However, it has also been observed that people prefer to use an artefact that they could understand better through a familiar context; that is, a context in which learning was not necessarily realized by means of using a native language (Bourges-Waldegg & Scrivener, 1998). But the salient point is that the person involved has established a strong positive learning association within the context despite languages differences.

As a legacy inherited from the internationalization-localization process, a stance underlying the state-of-the-art cultural usability research is that cultures differ in tastes, beliefs, and values, and therefore need different designs. It has been observed, however, that these factors are problematic for designers only to the extent that they act as barriers to understanding of intended meaning of representations (Bourges-Waldegg & Scrivener, 1998). It is known, for example, that colours have variable meanings across cultures. But it is important to note that the assigned meaning is not necessarily static. Colours have specific meanings in specific contexts. In Western cultures, the colour black signifies mourning in the context of a funeral, whilst it signifies elegance in the context of a premiere night at the opera.

The preceding line of argument provides a convenient basis for designers to sidestep the issue of cultural variability in values, language and preference. Differences in these dimensions are basically representational differences. Therefore it would be more fruitful for cultural usability approaches to refocus on the issue of understanding representations, and on accounting for the cultural specificity of representations.

4.2.4.2 Cultural usability evaluation

It has been argued that current cultural usability evaluation suffers from unexamined assumptions and thus it has to be realigned. This situation is not without irony. While usability testing seeks to align values embedded in the artefact with the values understood to be embedded in the target culture, the intrinsic values of the usability testing process itself is not necessarily aligned with the values of the people that usability testing endeavours to serve better.

Winschiers and Fendler (2007) identified a two-fold bias encompassing standard usability evaluation: first, through the definition of "usability" according to Western standards and secondly, through established methods aiming to test an already biased objective. Usability engineering has its roots in a tradition

that values rationalism, individualism, information, and efficiency. Thus the methods developed to serve the needs of evaluators are implicitly linked to the understanding of these concepts. Usability engineers and designers are not necessarily conscious of these biases embedded in their work processes, or they notice them only after encountering apparent failure of their evaluation participants in certain task performance during evaluation projects particularly in non-Western countries. (Winschiers & Fendler, 2007).

A starting point for the adaptation of current standard usability methods into the cross-cultural context is an awareness of their origin. This awareness aids in explicating the assumptions about notions of usability that should be analysed for compatibility with a target group's assumptions. The concept of efficiency in task completion might not be valid in certain cultural contexts. Namibians, for instance, have been observed to "fail" in task completion tests, but at the same time express satisfaction with a test artefact because of positive their feeling regarding the ease and quick mastery of the task. Post-evaluation interviews suggest that the participants stopped the evaluation because of the perceived feeling of mastery. Moreover, the evaluation method did not capture the instances when Namibians' rejected using the artefact because its content did not match their own knowledge, and therefore did not trust it. This type of finding suggests that the semantics of usability must be culturally realigned for each context of application. Usability evaluation involving people from several cultures also requires explicitly establishing an equivalent understanding of the concepts used in the process. Culturally realigning the semantics of usability could be realized through focus group studies to draw out culture-relevant concepts that are consequently adapted to the evaluation method. (Winschiers & Fendler, 2007).

Torkil Clemmensen arrives at similar conclusions, and proposes a theory—the cultural model of usability—for explaining cultural usability phenomena and a framework for deploying usability evaluations in multi-cultural settings. The cultural model of usability tries to explain cultural usability phenomena by viewing the notion of usability as "…the outcome of distributed cognitions across different kinds of culturally specific models: individual models, tool models, and situation models" (Clemmensen, 2009, p. 416). Individual models pertain to cultural models of technology usage consisting of goals, actions, and emotions. This definition broadens the traditional usability definition in terms of effectiveness, efficiency, and satisfaction. Tool models concern the affordance designed into artefacts. And situation models encompass usability evaluation methods.

The ambition for the cultural model of usability theory is to explain how people possessing multicultural backgrounds interact with technology. The theory posits several considerations:

(1) People possess multiple semantic systems that enable interaction with an artefact even if it presents conflicting cultural models of usage. Hence the usability of an artefact will be determined by the accessibility, availability, and

applicability of particular cultural models of use, which match one or more meaning systems possessed by the user.

(2) The notion of usability has pan-cultural status when viewed as a folk theory of the meaning of interaction with an artefact, and of what is deemed as appropriate mixture of elements contributing to its perceived utility.

(3) Usability is a pan-cultural construct to the extent that researchers want to make comparative measurements across cultures. This means measurements should be built according to the cultural context considering internal cognition, external artefact affordances and usability evaluation situations. "Internal models of use consist of the goals, actions and emotions that for an individual constitute effectiveness, efficiency and satisfaction of interacting with a product. The content and internal relations among effectiveness, efficiency and satisfaction when interacting with a product may vary across the world's population" (Clemmensen, 2009, p. 419). Variations in the internal models used in perception of the artefact, in the design of built-in affordances, and in the usability evaluation situations contribute to the measure of usability.

(4) The universality of usability could be linked to the computer artefact's property as an emergent arbiter of ways to do things. According to this assumption, the notion of usability is universal because the given artefact provides people with an object of activity, which provokes questions of function and utility in all cultural context. Hence since a computer artefact, as any other artefact, comes with a built-in model of use defining how and for what it can be used, it defines culture by defining ways to do things.

(5) Usability is built on broadly accessible knowledge resulting from the use of usability evaluation methods. The knowledge base is broadly accessible to a participating group within the context of the usability test. This accessible knowledge contributes to the emergence of a group conception of usability.

(6) Usability is primed by the computer artefact, language, and other parts of the evaluation context. Thus a test of a localized artefact containing culturally specific icons and pictures might prime the evaluator's and test participant's culturally specific knowledge system at the time when they do, for example, a think aloud usability test.

(7) Usability depends on the socially appropriate. The appropriateness of using accessible and available cultural knowledge comes into question particularly when the evaluator and test participants come from different sociocultural background. Sharing knowledge and coordinating descriptions of usability problems depend on the mutual perception of belonging to a group, and test participants might ask themselves implicit questions regarding the appropriateness of the available knowledge.

(8) The usability of a computer artefact is a hypothetical knowledge requiring confirmation or disconfirmation through actual use. The process of a usability evaluation, however, presents problems. A standard usability evaluation of a given artefact with a particular cultural model built-in will produce a list of particular usability problems. But because an established usability evaluation method acts as a mediator of the semantics of cultural models, an evalua-

tor might misunderstand the meaning of the cultural models in a specific context, yet still identify well known usability problems (as opposed to identifying new problems) linked to the context-specific cultural model. Therefore, a usability evaluation of an artefact for a geographical region unfamiliar to the evaluator might lead to identification of major usability problems, but this is not always the outcome of an evaluation that is meaningful to the context.

The cultural model of usability theory has implications for usability testing methods. Clemmensen and colleagues (2009) observe that the thinking-aloud method, with roots in Western cognitive science and a widely used tool in usability testing in the U.S. and Europe, has also spread in East Asian countries; but if the thinking-aloud method implicitly assumes a Western style analytic thinking, the usability researcher must make explicit thinking-aloud's effects on usability tests involving evaluators and participants', which are holistic in their style of thought.

Clemmensen and his colleagues found four elements of the thinking-aloud method susceptible to cultural effect: instructions and tasks, verbalization, reading the user, and overall relationship between the user and evaluator. Instructions and tasks given to test participants might introduce several biases (Clemmensen et al., 2009). Following studies on differences in cognitive styles between Asians and Westerners (Nisbett, Choi, Peng, & Norenzayan, 2001; Nisbett, 2003/2004), the authors reasoned that people from East Asian countries will perceive presentations of a usability task differently from their Western counterpart due to differences in cognitive styles. East Asians will more attend to the contextual information and might find context-free focal information superficial or difficult to understand. Westerners might find contextual-information superfluous and thus ignore it. In order to accurately interpret observations (i.e., reading the user), the evaluator and test participant must have similar perception of the given task, but if the evaluator and participant do not share sociocultural background they might not converge on a shared representation of the task.

These divergences might suggest different ways to complete the task. This situation complicates the analysis of participants' behaviour. The advantage of the talking-aloud method in giving evaluators access to what a participant is thinking rests on the premise that the participant's verbalization does not affect performance and that verbalizations are valid expressions of his or her thoughts. If one of these premises does not hold, the talking-aloud method will not accurately reflect the real use of the evaluated artefact, and the problem identified during the session might not be representative of the problem that will be encountered during actual usage. Differences in cognitive styles (i.e. analytic versus holistic) between East Asians and Westerners have been linked to performance in talking-aloud sessions. (Clemmensen et al., 2009).

Whilst verbalization seems relatively easy to Westerners and does not interfere with task performance, it is quite difficult for East Asians that it degrades their performance (Briley, Morris, & Simonson, 2000; Evers, 2002; H. S. Kim, 2002). Reading the user means evaluators listen to the test participants'

verbalizations and observe facial expressions and gestures in order to report the problems that participants experience. Clemmensen et al. (2009) explain that the practice of observation and grouping usability problems from the evaluator's perspective might vary depending on the evaluator's culturally determined cognitive style. One mechanism underlying the variation is field-dependence. In the talking-aloud method context, field-dependence concerns the extent that an evaluator's perception of usability problems is influenced by the context in which they take place. Evaluators with tendency toward field-independence might report more problems because they rely less on contextual cues as input for rejecting test participants' usability problems. Evaluators with these differing styles (field-dependent/field-independent) might report different types of usability problems because they attend to different aspects of the participants' experience with the artefact. Thus usability researchers must be aware of potential cultural bias in the problem identification process.

Contextual factors including psychological, social, and cultural factors might affect the overall relationship between the evaluator and the test participant, which in turn shapes what test participants say and how well evaluators read the participants. Cultural differences in communication style and approach to social relations might affect the communication between evaluator and test participant. East Asians, for instance, have been observed to rely more on conversational indirectness, and tend to assume that their point, particularly a negative one, has been made without being directly confrontational. Westerners in contrast tend to be more direct in conversational style[17]. Furthermore, differences in approach to social relations might affect the testing process, particularly if the evaluator and the test participant do not share a cultural background. (Clemmensen et al., 2009).

Approaches to social relations could also be characterized along the focal versus context orientation dichotomy (Clemmensen et al., 2009). Test participants with a context orientation will focus on the socio-emotional attribute of the relationship with an evaluator who do not share the same cultural background, and might express more positive comments about the test artefact even if they perform poorly on the given tasks because while they attend to the task, they will try to maintain a harmonic relationship with the evaluator (Yeo, 2001). Conversely test participants with a focal orientation will focus more on whether the given task is accomplished, and attend less to the socio-emotional context. Clemmensen (2012) points out that in certain cultures, an imbalance in the social rank between the test participant and evaluator influences the number of usability problems reported. For instance, if the test participant has a higher social rank than the evaluator, more problems are reported. A mismatch in the sociocultural backgrounds of a test participant and an evaluator also tend to influence the outcome. That is, test participants have a tendency to report more usability problems to interviewers who share their sociocultural background.

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17 Cf. Edward T. Hall's (1959/1973) description of high- and low-context communication styles.

The language used in usability testing might also affect the outcome. (Clemmensen et al., 2009). It has been observed that the use of English or Chinese might prime different cognitive styles for bilingual Chinese test participants who grew up in an environment dominated by Chinese culture and language and use English as a second language (Ji, Zhang, & Nisbett, 2004). Thus cultural usability researchers must be sensitive to the potential for misreading the test participant in usability testing situations involving evaluators and test participants with different cultural backgrounds.

The most important contributions of the findings from cultural usability evaluation research are the proposals for culturally informed theories, and the consequent call for increased awareness that evaluation methods are susceptible to cultural effects. Specifically, human-technology interaction researchers must realign their evaluation methods in order get the most meaningful measurements possible. Assumptions about the universal applicability of protocols such as thinking-aloud will have to give way to a process that includes analysis of the cultural factors within the given usability evaluation situations. Employing standard usability testing methods in culturally diverse setting carries the risk of missing important usability issues. It is becoming clear that the emphasis on task completion by standard usability definitions might be opposed to the perception and experience of the utility of interacting with technology in other countries. Thus there is impetus to put more emphasis on the subjective experience of people to better understand how people from different cultures experience the quality of their interaction with technology.

Whilst connecting cultural variability to usability issues is useful in realigning products, the approach falls short with regard to having a holistic framework that assists designers to address issues beyond the scope of usability. This realization has contributed to developments in emotional design research.

4.3 Emotional design

The subdisciplines of usability and user experience research have contributed to the continuing evolution of the human-computer interaction discipline and hence to the design and development of artefacts that are pleasurable to use. It is often difficult to differentiate between the purposes of usability and user experience evaluation methods due to the generic definition of the two concepts, and the undifferentiated characteristics of the measures of usability and user experience (Bevan, 2009). In the context of user centred design, user experience research and design endeavour to understand and design the way people interact with artefacts to optimize people's performance; and to maximize people's achievement of hedonic goals of stimulation, identification, evocation and associated emotional responses in order to optimize the feelings of satisfaction with the artefact (Bevan, 2009).

People perceive artefacts through their pragmatic and hedonic attributes. They perceive an artefact's utility and usability in relation to tasks—for example,

communicating with a friend, checking the status of a bank account—through its pragmatic attributes. Through its hedonic attributes, people perceive an artefact's ability to support goals of being—for example, being autonomous, competent, simulated, and being related to others. (Hassenzahl, 2008).

Although, both pragmatic and hedonic attributes contribute to the overall user experience, the hedonic quality of an artefact provides the key link between the study of user experience and cultural factors. The artefact's hedonic attributes directly contribute to a positive or negative aesthetic experience and thus could be linked to the study of aesthetics. Various challenges with methodological consequences for practical evaluation of aesthetic experiences come with this enterprise. How does one operationalize the constructs of hedonic quality and aesthetic response? What cultural constructs could one use? The prominent strategy is to examine the relationship of visual aesthetic and emotion.

The study of cultural factors and visual aesthetics provides the proverbial low-hanging fruit for a convergent strategy of cross-cultural user experience research. As such it is already a step beyond the strategy of putting a useful artefact in a beautifully designed box (Hassenzhal, 2008). There is still paucity in studies of aesthetic responses to hedonic qualities at the conceptual level. User experience researchers are aware of the potential of conceptualizing and designing specific functions that enable goals of being, but these processes entail continuously clarifying the goals of being and understanding how they converge and diverge along sociocultural dimensions. Current work on the use of culturally aligned metaphors provides one important path toward a better understanding. However a more problematic gap, in terms of methodology, lie in the methodological framework used for the study of emotions in information and communication technology design.

Critics argue that exploring the roles of emotion within the traditional cognitive framework of information processing can result in poor understanding of how people interactively construct and subjectively experience their emotions, and hence can lead researchers to an inadequate understanding of everyday actions as situated in social and cultural contexts (Boehner, De Paula, Dourish, & Sengers, 2007). One needs to examine and understand this criticism concurrently at two levels: in terms of plugging holes in the methodological framework in current use, and in terms of presenting a different perspective on the production and validation of empirical knowledge.

The application of emotion as a cultural construct to the design of user experience is highly dependent on the universal aspect of emotion. Emotions are considered to be universal to humans but cultures differ in the conceptions of socioculturally appropriate or inappropriate expression of emotions (Matsumoto, Nezlek, & Koopmann, 2007; Matsumoto, 2008). From the perspective of design, a deep understanding of emotion's universal aspects aid in articulating forms and functions that provides the necessary emotional connection to the given artefact.

The notion of emotion as a cultural construct enables researchers to work with an objectively quantifiable construct that can be linked with preferences, for example, aesthetic preferences concerning the form and function of artefacts. It is a convenient method for mapping aesthetic elements to culturally predetermined emotional responses, thus helping to achieve congruity between design elements and culturally determined preferences. Whilst this approach acknowledges the notion of emotions as culturally grounded, the mapping process could be faulty and its result could be inadequate, if it exclusively employs an information processing framework, in which emotion is defined as objective, internal, private and mechanistic as well as analogous to performance, efficiency and technical achievement within interaction (Boehner et al., 2007).

Why is this problematic? Boehner et al. (2007) argue that an historical precedent regarding the scientific conceptualization of emotion is repeating itself in the field of human-computer interaction. In the process of finding a way to make emotion experimentally accessible and compatible with existing research models, the definition of emotion has been changed to fit a conception of science as rational, well defined and culturally universal. Aspects of emotion that do not fit this view—aspects that are not objectively accessible and measurable, and vary over cultures over time—are ignored. Boehner et al.'s (2007) view resonates the problem with the general usage of "universal" concepts and with unexamined assumptions in design research. It also resonates the limitations of using cultural models of values linked to the psychological construct of emotion in the research strategy.

According to Boehner et al. (2007) whilst researchers pursuing a user and culture-centric approach attempt to deconstruct the conventional approaches to cognition and the underlying cognitivist computational model, they nonetheless depend on them as a basis for understanding emotions. Situating emotions within an information model unintentionally but effectively ignores the issues of interpretive flexibility, of providing possibilities for an expanded form of communication, and of focusing on people's usage of artefacts in order to understand and experience emotions. Interpretive flexibility means allowing people to define and interpret emotions, in contrast to mapping the different meanings of emotions to elements of an artefact and having these elements supply the meaning of formalized emotional expressions to people. The underlying rationale is that emotions as experienced by people in complex social and cultural ways do not map neatly to formalized emotional structures. Therefore formalized emotional expressions mapped onto the artefact might unintentionally force people to use emotional expressions that are at best misleading, or to have a negative aesthetic experience rather than a positive one as expected by the designer of the artefact.

Enabling provisions for expanded communication means allowing people to define their own signs, indices and icons in order to give a more open-ended sense of the complex emotions they are experiencing during communications. Focusing on people's usage of artefacts for experiencing and understanding emotions requires an ontological switch in the conceptualization of an artefact's

function. Instead of functioning as a transmitter of emotion as information, it serves as a supporter of emotional experience and construction. Therefore, the focus of design is to make people more aware of emotions through the use of the artefact, rather than making the artefact more aware of emotions. (Boehner et al., 2007)

Boehner et al. (2007) propose an interactional approach that sees emotions as culturally grounded, dynamically experienced, and constructed in action and interaction. This approach has important implications for interface design: it focuses on helping people to understand and experience their own emotions, rather than focusing on helping computers to understand better the human emotions. The approach leads to design and evaluation strategies that emphasize the co-constructed and co-interpreted characteristics of emotion. An artefact designed by using the interactional approach to emotion is measured according to whether it is successful in encouraging awareness of and reflection on emotion on the individual and collective levels.

In effect, Boehner et al.'s (2007) proposal implies not only a re-tooling of the methods used to study emotion as a cultural construct, but also a reconsideration of the epistemic basis underlying most of cross-cultural emotional design in particular and design research in general. The notions of culture as collective programing of the mind, and of emotion as delineable and objectively measurable play a central role in current information and communication technology design particularly in human-computer interaction research. The gap in understanding the role of emotion is articulated in the cross-cultural ICT design literature as an inherent weakness in exclusively employing value dimensions or using national identity as proxies for culture in designing and evaluating artefacts (Callahan, 2006; G. Ford & Kotzé, 2005), as a need for alternative approaches for capturing the nuances of dynamically experienced phenomenon such as emotion during interaction with and through technological artefacts, and as calls for more detailed examination of cultural sensitivity regarding aesthetics above and beyond quantitatively demonstrating that culture affects aesthetic responses.

Where are the gaps? Affective computing research related to artificial intelligence, for example, conceptualize emotion as discrete and measurable in order to model emotions in synthetic characters (G. J. Hofstede, Jonker, & Verwaart, 2013; Nazir et al., 2009). The strategy is to represent cultural variation in emotion exclusively through value dimensions derived by numerical evaluation of questionnaires and linking these dimension to measurements of emotion frames, cultural variables, and conceptualization of emotion within the information processing model. Therefore current cross-cultural research related to artificial intelligence is yet able to support the expectation of supporting people to better understand their emotional responses.

Whilst connecting cultural variability to user experience is useful in realigning artefacts, the approach falls short of having a holistic framework for designing for life that results in easy to use, enjoyable and useful products. User experience as it is conceptualized and practiced in Western academic and in-

dustry research has many touch points with affect-based design and engineering approaches developed in East Asia, namely kansei research and design, and citarasa engineering. The cultural gap, however, must also be bridged. We examine next the kansei and citarasa approaches.

4.3.1 Kansei research and design

Kansei and user experience research share a common ground in understanding human affective needs in relation to artefacts. Lévy, Lee and Yamanaka (2007) observe that while the approach has been widely applied in academia and industry in Asia, its adaptation and development have lagged in the West. The term kansei does not have a direct translation in English. Lévy et al (2007) suggest that the lack of a comprehensive definition of kansei is the first barrier to Western understanding of the concept. S. Lee, Harada and Stappers (2002) explain that the early development of the term is linked to the influence of the German philosopher Baumgarten with his work *Aesthetica*. But as Lévy et al (2007) point out, subsequent iterations on the development of the term, which eventually surfaced in Western design community through the work of Mitsuo Nagamachi on "Emotional Engineering" and of Kenichi Yamamoto (who served as president and chairman of Mazda and credited for the invention of the term kansei engineering) in the 1980s, have been conceptualized from Japanese culture-specific perspectives that do not map easily to Western cultural concepts. For instance, the kansei construct is founded on the interdependency of sensation, perception, and cognition processes. As previously observed, the concept of interdependence is characteristically dominant in Eastern thought, while in contrast Western thought tend to focus on the independent relationships of constructs (Nisbett et al., 2001; Nisbett, 2003/2004). Hence there is a cultural gap between the disciplines of user experience and kansei that must be bridged before one can find points of convergence.

It is instructive to note the brief history of the etymology of kansei. According to Simon Schüte, while issues addressed by kansei design can be traced to Baumgarten and the introduction of Western philosophy to Japan by Amane Nishi (Schütte, 2005), Teiyu Amano created the Western philosophical links to kansei when he translated Immanuel Kant's *Critique of Pure Reason* in Japanese. Amano used the term kansei to translate the term sinnlichkeit (Nagasawa, 2002).

Lévy et al (2007) argue that sinnlichkeit and kansei are epistemologically differentiated through their cultural and philosophical backgrounds. While sinnlichkeit traces its pedigree to a tradition of asking "why", kansei is steeped in the tradition of asking "how". Kansei research is mostly concerned with understanding and improving the effects of kansei on humans and their environment, rather than determining the essence of kansei. Toward this end the authors propose a comprehensive description of kansei in terms of process, means and result. The rubric *kansei process* subsumes the functions related to emotions, sensitivity, feelings, experience, and intuition as well as interactions between these functions. *Kansei means* pertains to all the human senses, and psychologi-

cal factors such as personality, mood, and experience. *Kansei result* describes how one qualitatively perceives one's environment.

Research applied to kansei engineering (Nagamachi, 2002; Nagamachi, 1995) aims at measuring the kansei process via observations of the causes and consequences of the process (Nagasawa, 2002). Physiological indices are measured by evaluation of physiological or behavioural responses to given stimuli, and these responses are measured by electromyography (EMG), electroencephalography (EEG), event-related potential (ERP), or functional magnetic resonance imaging (fMRI). Psychological measures are done with personality tests, semantic differential scales or other questionnaires (Lévy et al., 2007).

Some kansei researchers have acknowledged the inherent weakness in using semantic differential scales in the methodology and have proposed ways to mitigate them (Nagasawa, 2002). The issue of cross-cultural interpretation of kansei words used in the semantic differential scales, however, deserves further examination. Without elucidating the variation in interpretations, it might be difficult to separate the difference in cross-cultural linguistic understanding from the differences in responses to stimuli (Peranginangin et al., 2011; W. Shen, Matsubara, Wilson, & Nagamachi, 2000). Hence kansei design and engineering processes must also be made culturally responsive. The automotive industry has been one of the forerunners in the application of kansei design and engineering (Nagamachi, 2002; Nagamachi, 1995). Its application has also been linked to ergonomic design in projects such as design of hospital beds (Nagamachi, Ishihara, Nakamura, & Morishima, 2013). For specific application to the automotive industry, there is an alternative approach to mapping people's affective needs to product design: citarasa engineering.

4.3.2 Citarasa engineering

Citarasa engineering provides an alternative approach to kansei engineering. The citarasa system is based on the assumption that a person, for instance a customer of a given product, already knows what she or he wants, and understands how a product will fulfil her or his emotional needs. Whereas kansei engineering's aim is to describe products by using affect adjectives, citarasa engineering's starting point is a description of customers' emotional needs (Khalid, 2006). Citarasa engineering is designed specifically to support mass customization, the concept of mass-producing products tailored to the individual needs of individual customers. To this end the approach endeavours to support the so-called do-it-yourself design by customers as well as product re-configuration by product planners (Khalid, Dangelmaier, & Lim, 2007). The theoretical framework supporting citarasa engineering explicitly addresses cultural variation in emotions as applied to affective design (Khalid & Helander, 2004; Khalid & Helander, 2006); hence researchers using the approach should be reminded of the requirements to cross-culturally validate instruments such as semantic differential scales.

While the citarasa system aims to provide users and creators of technological artefacts with a holistic approach to elucidate relevant needs and desires, it

has an inherent weakness in relation to its aim of supporting mass customization. One can argue that from the affective perspective, the intended outcome for mass customization of "satisfying customers current needs by offering individualized products at low prices…"(Khalid et al., 2007) is limited. From the manufacturer's point of view, one cannot design a completely customized product (i.e., radically different in form, function and features for each individual customer) with mass customization techniques. One can only provide a selection from a fixed point of options. It is also questionable whether the resulting customization is emotionally compelling (Norman, 2004). Nevertheless, the citarasa engineering is an exemplary attempt toward a culturally responsive human-technology interaction. Other approaches are being developed, and these are examined next.

4.4 Socio-technical systems design

Socio-technical systems design shares similar concerns with the approaches described above. It advocates user-centric and participatory design methods in order to ensure an appropriate level of consideration for human factors in the systems engineering process.

Socio-technical systems design traces its legacy to work began in the 1940s at the Tavistock Institute in London. Concepts and methodology developed at this time aimed at fostering improved relations between people in organizational work settings. By the 1970s, the institute began using the concepts and methodology in the design and introduction of computer systems in organizations. The evolution of socio-technical system design is linked to the development of Scandinavian collaborative design concepts (see discussion in chapter 4.7.3). The Scandinavian projects employed similar concepts and at the same time broadened the conceptual scope to address issues involving labour politics and labour-management conflicts. (Scacchi, 2004).

It has been suggested that a contemporary socio-technical system is a social system founded on technology such as email and the so-called social media. One can define socio-technical design as the application of social principles to such technical systems (Whitworth & Ahmad, 2013). While doing so enables researchers to employ an analytical framework grounded in social science for examining complex interactions constituting social requirements, one must also address the observed variations in social principles (that is, information associated with social networks) from one society to another, and differentiations in the meanings of these principles across cultures within and between societies.

To sum up, there are many implications of the relationships between culture and technology to the design of human interactions and relevant technologies. From a cultural point of view, the process of reception could constitute the transmission of a technology into a different culture while the meanings deemed by its originators to be inevitably attached to it might be completely left out. The technology might be used for similar purposes, but the interpretation

of its meanings is determined by the internal references of the receiving culture. Hence in the process of reception both the technology and the receiving culture are modified.

4.5 Website design

Websites as an arena for global interactions, from the perspectives of human-to-human and human-technology interaction have been the point of departure for many researchers' calls for culturally informed design and development frameworks. Works published in the early part of this century (e.g., Marcus & Gould, 2000; Marcus, 2002) has set forth a series of calls for integrating cultural constructs in website design, but most of consequent research still tended to focus on usability, and thus fall short of establishing integrative design frameworks that go beyond cultural usability issues.

4.5.1 Meaning in mediated action

Paula Bourges-Waldegg and Stephen A.R. Scrivener's analysis of the internationalization-localization model prompted a proposal for a return to understanding representations as the focal point to creating culturally informed artefacts, rather than focusing on cultural differences. The authors argue that the key cultural variable in user interface design is the variation in cultures' representational systems. However, after acknowledging the importance of this variability, it is also important to note that people from different cultures can have shared contexts, due to the interactions between cultures. Intercultural communication is made possible by a common understanding of the representations used within a given context. Hence the key issue in designing artefacts for a culturally heterogeneous group is to design representations that could be understood within the context shared by the group, rather designing different representations for each group. (Bourges-Waldegg & Scrivener, 1998). This argument resonates a universal approach to user interface design. From the perspective of creating integrative research strategies, the underlying rationale fits well with having a focal point inclusive of cultural variability, on to which designers could converge.

Bourges-Waldegg and Scrivener (2000; 1998) propose the "Meaning in Mediated Action" framework to determine what contexts shared by a heterogeneous group could be used as a basis for designing representations. It relies on understanding the cultural specificity of representations. Cultural differences are framed as representational differences. Hence, interactions are analysed through representations and meaning, specifically through their mediational properties. This approach was originally develop to analyse website interfaces, but it should be applicable to any type of interface since all interfaces and interaction styles involve representations, meaning and context. It could also be applied to any element of the system, from the colour used in the inter-

face to the working environment. The framework focuses on people's understanding of the intended meaning of a representation in a particular context. A representation is defined as any aspect of the given artefact that conveys or is intended to convey meaning; a meaning is what the representation conveys, and a context refers to how and where a representation is used, as well as to the representations surrounding it. Situating the design problem in this framework leads the designer to focus on three areas:
(1) Evaluating whether culturally diverse users understand the meaning of a given representation in a given context.
(2) Determining whether users share the context in which meaning is rooted.
(3) Designing or redesigning representation from the shared contexts that has been identified.

The framework is deployed in four stages of observation, evaluation, analysis, and design. Rapid prototyping and structured interviews are used in these stages. The observation stage entails observing a sample of the target group interacting with the artefact in order to understand how representations mediate the user's actions, and to determine any breakdowns in the mediation. A breakdown is defined as a situation wherein a defect in the artefact triggers an action from the user to "break it down" (Bourges-Waldegg & Scrivener, 2000, p.114) in order to clarify the problem. The focus is on problems related to understanding of the intended meaning of the representations involved in the artefact.

In the evaluation stage, a different sample of culturally diverse users is interviewed to ask about the meaning of each problematic representation identified during the observation stage. During the interview, the prototype of the artefact should prevent possible learning of the intended meaning by using the artefact. This can be set up for example by employing a prototype with minimum functions operational instead of using a fully functional artefact. The analysis stage is done in three ways: (1) by comparing the intended meaning of the representation with the user's definition, and assessing whether the user's understanding produces misconceptions; (2) by comparing all of the test participants' assessments to determine the cultural specificity of each representation. Representations that are understood by the majority of the participants could be considered relevant to a shared context. The rationale underlying this conclusion is that knowledge of a representation's context is required in order to understand a representation. Therefore, if users understand a particular representation, this means they know and share its context. (3) By comparing the participants' definitions in order to find common usage of representations. (Bourges-Waldegg & Scrivener, 2000; Bourges-Waldegg & Scrivener, 1998).

The Meaning in Mediated Action framework encourages designers to move their focus from producing more documentation about cultural differences relevant to design, and consequently creating more lists and guidelines. Its call for concentration on representations and the challenge of aligning their meanings within a shared context provides a point for convergence, and as such contributes to the effort of moving toward integrative design frameworks. This

framework offers obvious advantages over the internationalization-localization processes to the extent that it offers a prescriptive approach to integrating known cultural differences to the design process particularly when designing artefacts such as websites targeted to a multicultural context. In contrast, other researchers argue for a need to dive deeper into a culture of interest in order to realize a culture-centric design that better reflects the needs of the community.

4.6 Learning environments

Researchers in the domain of learning environments provide examples of ongoing work, and of calls for using culturally sensitive design frameworks specifically applicable to designing e-learning tools for intervention programs in classrooms—for example, tools such as "Collaboratory Notebook" (C. D. Lee, 2003) and "Virtual Peers" (Cassell, Geraghty, Gonzalez, & Borland, 2009) in the United States; serious games for health education in Mexico (L. V. A. Harris & Adamo-Villani, 2009); basic reading skills for rural children in India (Kam, Kumar, Jain, Mathur, & Canny, 2009) and for children in an indigenous community in Colombia (Rincón et al., 2011). Several frameworks have been proposed for designing cultural relevant software for this domain.

4.6.1 Cultural modelling design framework

A seminal work by Carol D. Lee (2003) sets the tone for the collective challenge to designers to take into account how cultural practices, especially among students of colour and those living in poverty, offer opportunities to improve learning technologies. Lee argued for incorporation of ethnicity and language use into concepts of learning principles as well as to design principles, and offered a design framework—"Cultural Modelling Design Framework" (C.D. Lee, 2003, pp. 45-46), which is based on research in the learning sciences, cultural psychology, and cultural-historical-activity theory. The framework evolved from Lee's theoretical and empirical research in culturally responsive teaching and learning. It has been expanded into a model for incorporating cultural socialization and identity into learning. Designers of learning technologies—i.e., computer based as well as non-computer based tools—can use the framework to (1) analyse an academic domain, and the relationships among problem types in the domain; (2) elicit data on the target group's prior knowledge, which may be related to the process of doing a given task—e.g., problem solving, and literary interpretation; (3) consider the motivational potential of instructional conversations, and draw on community based norms of discourse, in order to structure activities that help students draw out for themselves and others the tacit strategies they already use outside of school, and to establish congruity between instructional talk and community based norms of talk, which may include use of different national language—e.g., in the U.S., the use of Spanish and language varieties such as African American English Vernacular; (4) strate-

gically select the content of the tasks—i.e., structuring tasks according to the cognitive demands of the academic domain, and providing content that address community and personal issues.

Lee applied the design framework to the design of a high school literature curriculum and the redesign of a software tool for an intervention project in an underachieving African American urban high school. The author concluded that a culturally responsive educational design contributes to the development of situated theories of learning. Whilst the dominant cognitive research literature on educational design in the U.S. emphasizes the salience of understanding participants, context and tasks, it rarely addresses the significance of participants' culture—as experienced through ethnicity, race, and language variation—to the complexity of learning. Lee argued for a culturally responsive design approach applied specifically to computer based educational tools in order to address the impacts of inequity in computer usage at schools serving students of colour and students living in poverty, the effects of assumptions that computer based tools used in schools are culturally neutral, and the impacts of evaluation methods for appropriation of learning tools, all of which might be unintentionally contributing to the learning achievement gap in the U.S.

Lee's Cultural Modelling Design Framework is exemplary of early efforts to provide a cultural instructional design model that explicitly considers socio-cultural and socio-economic factors in design concepts. The model's focus on communications styles guides designers to concentrate on linguistic factors that cause problems in multi-cultural learning environments. Missing from the framework, however, are components that help designers analyse and address issues concerning cognitive styles, and aesthetics. No provisions have been made either for analysis of biopsychological factors, e.g., age/aging, gender, and disabilities. Hence the framework needs to be extended in order to be applicable to more domains of actions and communities of practice.

4.6.2 Culture based model

Patricia A. Young proposed the "Culture Based Model" for application in instructional design. Young's instructional design framework "…guides designers through the management, design, development, and assessment process while taking into account explicit culture-based considerations" (Young, 2008, p.107). The model is meant for designing technology products and services targeted to the learning environment. The Culture Based Model evolved from Young's research of instructional products made by and for African Americans. Young identified 70 design factors, and grouped them under thematic areas namely: inquiry, development, team, assessments, brainstorming, learners, elements, and training. From a process perspective, some of the themes concentrate more on project management, while others focus on design. Young (2008) defines project management as inclusive of the themes inquiry, development, team, assessments, brainstorming, learners, elements, and training, while design is inclusive of content development and monitoring.

According to the model, the main aims for the inquiry process is to make explicit the following pre-design decisions: selection of a given ICT for a project; alignment of content to the target audience; reasons for intentional or unintentional omission, or underemphasis of data input to the project; reasons for emphasis of certain data input; how selected visual presentations frame the envisioned product.

The "development" design factor provides direction for problem solving in the context of project management. Ten other design factors are subsumed under this theme. The aims for these factors are to assess: (1) the design specifications involving technical, aesthetics, content, cultural basis, and intended audience; (2) the distribution format for the product; (3) available technology; (4) the needs for distribution format diversification; (5) the needs for data collection; (6) artefacts used to represent the target culture; (7) possibilities for replicating the envisioned product; (8) the portrayal of societies, peoples, and cultures; (9) attitude bias and prejudices; (10) the modelling of products or processes.

The design factor "team" is used in decisions concerning the make-up of the design team. This means putting together a design team that includes an expert in culture, and educators who are subject matter experts or experts in educating the target group.

"Assessment" concerns the evaluation process during project management. The evaluation process covers measurements of the learner's acquisition of knowledge, or the effectiveness of the product design. This assessment is in turn evaluated to screen for bias. Project outsiders implement a project evaluation in order to get an external view, a summation of learner's progress and the effectiveness of the product. Culture-specific assessments are used to evaluate culturally aligned content.

The design factor "brainstorming" subsumes the various elements in managing the planning process during project management. The sub-design factors in this area determine the overall direction of the project. As part of the project management process, pilot studies and field tests of the product are evaluated. These evaluations provide data on the target audience's interactions with the product and serves as a measure of the design's cultural relevance. The target community's response to the product is assessed. Assessment takes the form of focus groups, surveys, or public-opinion polls (i.e., in-person, telephone, or online).

The "learners" design factor concerns the learning aspects of the project management. The sub-design factors in this area support people's cultural frame of reference while meeting the learning outcomes of the project. This process aims for design concepts that adapt to learners in terms of variations in proficiency levels, educational objectives, and aspects of the target audience's life (e.g., politics, morality, ethics, beliefs, language, identity, and social actions) as well as in terms of culture specific instructional strategies.

The "elements" design factor concerns content development. The sub-design factors in this area provide elements representing the fundamental composition of all cultures. The objective in this process is to analyse the target cul-

ture by drawing from the reference fields (e.g., anthropology, psychology, physical and biological sciences). Finally, the "training" design factor addresses the need for product and culture based training.

Young's Culture Based Model provides the designer comprehensive lists of design factors that could facilitate a broad examination of culture, instruction, learning and the application of these factors to cross-cultural audiences. It is useful for asking high-level questions to assist the management of the design process. This model could be employed to extend C. D. Lee's proposed framework; however, it can potentially become unwieldy and difficult to navigate for software designers in need of a more direct guide to support the design and evaluation of a software artefact.

4.6.3 Culture relevance design framework

Wanda Eugene and colleagues (2009) proposed the "Cultural Relevance Design Framework" with a specific goal of assisting and encouraging software designers to create culturally authentic technology. The authors seek to bridge the gap between technology designers and the recommendations of educators and researchers of culturally responsiveness in instructional design regarding integration of cultural models in the design process. They reasoned that it is difficult for software designers to operationalize findings and recommendations found in the instructional design discipline because these data are primarily used to guide creation of curricula, lesson plans, and teacher worldviews. Hence they created a framework that provides questions to inform the design decisions particularly at the early stage.

The framework is set up to uncover designers' beliefs and biases about their target audience, to bring out the design relevant aspects of the audience, and suggest cultural assets for evaluation for their potential as basis for cultural representations. The framework is also meant to inform decisions at the beginning of the design process as well as situate the cultural relevance evaluation of products throughout the production process. The framework has been proposed as a response to calls for "integrating culturally relevant pedagogy into classrooms as a method of student engagement, curricula development, knowledge construction, reflection, and applicability of skills learned" (Eugene et al., 2009, p. 20).

Drawing from L.S. Vygotsky's work (Vygotsky, 1978 as cited by Eugene et al., 2009) on cognitive development processes, the authors use the cultural relevance design framework to extend the sociocultural learning theory. According to this theory, all learning and cognitive development happens in a cultural context and are influenced by language and symbols, which play a major role in the cognitive development of children. The authors integrate their work with the work of researchers of learning environments who have observed that students of different cultural backgrounds process information differently. A particular point of interest is the differences between African American and European American children in story-telling style, question-asking style, oral language, and knowledge of print conventions. Research findings suggest poten-

tial benefits for applying culturally responsive strategies to teaching reading, science, and math.

The authors define culture along the dimensions of behaviour and ontology, and describe how these are examined within the themes of practices, ontology, representation and tasks. Examining the dimensions in the context of practices requires a designer to identify and understand the cultural practices and social norms associated with the targeted group. Practices are the agreed upon activities in which members of a culture participate. Members are enculturated, and they learn and understand the meaning of a range of activities in a particular context. This theme enables designers to describe the range of design relevant practices attributed to the target group, and to consider how they can be integrated into the learning tasks of the technology. Every culture has a shared "organizational structure of knowledge … for problem solving" (Eugene et al., 2009, p. 23). Ontology is defined as "the shared or understood vocabulary of a culture or community of practice" (Eugene et al., 2009, p. 24).

The theme of ontology reminds the designer that culturally relevant software reflects the ontology of the target culture. This means the designer should become aware of the way instructions and feedbacks are given, the common vocabulary, and the language conventions practiced by the members of the target culture. Representation is defined as visual cues and symbolic thoughts that reflect the patterns, values, knowledge and beliefs of a group. This theme reminds the designer to ensure authentic representation of the target culture's perception of behaviour and visual cues (for example clothes, gestures, activities). The imagery, perspective and graphic images should reflect the culture and cultural norms. Representations of aspects of appearance such as body, face, shape, ethnicity, age, clothes, gestures, and eye contact must be respectful of the culture. Tasks are the activities that people engage in while completing their goals with technology. The designer considers the activities typically linked to a person's age, gender, and to what they do.

The authors recommend applying the framework in four steps which involve: (1) examining beliefs and biases toward the target culture; (2) determining the framework themes that are applicable to designing and reviewing the suggested criteria; (3) employing the suggested criteria to identity the social-cultural norms, and creating strategies for getting additional information if required; (4) incorporating the learning into the design, and continuing to use the framework as an evaluation tool throughout the whole production process.

Eugene et al.'s (2009) contribution to the culturally responsive design literature is one of the early endeavours to present a cohesive framework based on pre-existing disjointed culturally responsive models located in the disciplines of education, psychology, anthropology, and computer science. The advantage of the Cultural Relevance Design Framework over its predecessors lies in its integration with culturally responsive approaches employed in the closely related discipline of instructional design, and its provision of a practical process, inclusive of a guideline for application that is adaptable to various stages of the ICT design process.

By situating the framework within a sociocultural learning theory, the authors sidestep the issue of finding measurable cultural constructs that could be linked to various elements of an artefact. Instead, the focus switches to ethnographic studies of the target group in order to assist designers to foreground their assumptions, and to discover design relevant sociocultural norms at the beginning of the design process. Flexibility is built into the framework in terms of the possibility of growing the number of criteria (themes) for examining the two dimensions of culture proposed by the authors. This is a valuable approach because it allows others to easily extend the framework in order to address its weaknesses. In particular, it is not clear whether the proposed criterion of "Tasks" is adequate in helping designers to unpack relevant sociocultural norms applied to the biopsychological attributes of age and aging, gender and disabilities, not only in terms of describing them, but also in realizing the implications on the other proposed criteria.

4.7 Cultural conflict and design

Winschiers and Fendler (2007) have proposed a culture-centric development approach specifically targeted to software engineering projects, and its main function is to foreground the cultural realignment of the usability criteria according to the target group's conceptualization of usability (cf. postcolonial computing, in this chapter). This means the definition of the usability criteria is negotiated through intensive participation of the target group in conceptualization sessions already at the early phase of the design process. The results are subsequently employed to "acculturate" (Winschiers & Fendler, 2007, p. 459) the user interface design, development (e.g., Agile development, Extreme programming and prototyping), and usability evaluation processes. The main contribution of this approach to the movement toward integrative framework is its use of usability as the pivot concept in identifying the needs of the target audience, and in incorporating cultural relevant factors into the development processes.

Using usability as a pivot concept could be useful in a multicultural setting where the characteristics, epistemology, and ontology of cultural practices involved are similar and could be subsumed under, for example, a Eurocentric view. But it is doubtful whether this approach could aid the designer in creating representations of cultural practices that have little or no similarities.

4.7.1 Designing for indigenous communities

Pumpa and Wyeld (2006) point out the existence of vital differences between the European Australian and Australian Aboriginal people's experience of knowledge. The European Australian knowledge tradition, rooted in Western epistemology, emphasizes the difference between an existing object and its representation in various symbolic systems, whereas Aboriginal knowledge tradi-

tion emphasizes the unity of object and symbol. Hence representations such as language, ceremony, singing and dancing could influence events and cause real world events to occur. Phenomena and objects could come into and go out of existence through representational forms. There is no notion of duality between phenomena and representational form. In this sense, Aboriginal representational forms are non-representational compared to the Western dualist conceptualization.

Another principal difference that needs consideration is that Aboriginal knowledge is associated with their land, inclusive of the relationships that people have developed with the land over time (Munn, 1996; Pumpa & Wyeld, 2006). This knowledge is primarily embedded in kinship, language and humour rather than objects, artefacts or written records of the relationship (Pumpa & Wyeld, 2006). Moreover, there is the issue of who is allowed to transmit the knowledge. Aboriginal narratives are the prerogative of the elders (men and women) in a given community. The rules of transmission are highly regulated (Verran & Christie, 2007). Thus in order to create an artefact that appropriately serves the needs of people in this particular domain of action, it becomes obvious that the designer must rely on other approaches to discover the users perceived needs, which would be difficult to draw out by a usability focused analysis.

Other authors (e.g., George, Nesbitt, Gillard, & Donovan, 2010; Rincón et al., 2011; Verran & Christie, 2007) have proposed similar community-centric approaches akin to collaborative design. They are similar in their recognition of the need for ethnographic studies to understand issues that go beyond usability. Current research in designing for indigenous communities takes a pragmatic approach of working with components of existing technology systems.

Pumpa and Wyeld (2006) used existing technology for three-dimensional computer games to operationalize the performative feature of Australian Aboriginal narratives. In their work of building technological support to the Nasa people of Colombia in preserving their language through a strategy of creating a writing system, Rincón et al. (2011) developed a cultural model consisting of six variables, which they applied to the development of computer-based tools: language, space, environment and technology, social organization, notion of time, and non-verbal signs. Under the rubric "language", the authors gathered information on language related issues such as the lack of basic computer glossary in the Nasa people's Yuwe language as well as the lack of some of the modern Yuwe characters in existing keyboard layouts. The rubric "space" subsumes the study of space structuring found at different levels of daily life such as the Nasa three-stone hearth, the house garden and the "resguado" or the collective territorial land.

The resulting data are applied to the design of representations using familiar metaphors. The "environment and technology" rubrics encompass the study of relevant ecological factors and available technology. The resulting data are applied also to design decisions on appropriate metaphors, and on the type of current or new technology that could be supported by the environment. The

social organization rubric embraces a range of variables. In the Nasa project, the focus was on the educational context for Nasa children, and the community-orientation manifesting in the aspects of work preferences and territory. The notion of time and non-verbal signs rubric comprise the examination of indigenous concepts of time, and important symbols representing worldview and time/life cycles.

George et al. (2010) suggest that knowledge representations have to reflect the different schemata found in indigenous cultures. And while this suggestion is aligned with the general principles of designing cultural responsive artefacts, there is still the problem of how to operationalize the representations by using contemporary technology artefacts (e.g., relational database software), which have been criticized for their inability to support a non-representational, non-dualist worldview.

If this criticism specific to information and communication technology holds true in relation to all cultures rooted in the non-dualist tradition, entire sets of software programs that are employed as foundation for other programs will have to be redesigned and rebuilt in order to allow indigenous communities to fully negotiate their metaphysics in the transmission and understanding of knowledge. Current research in designing technology artefacts for indigenous communities implicitly include issues of power inequalities along the lines similar to those foregrounded by researchers with a postcolonial analytical orientation (see the section of postcolonial computing in this chapter). It is not yet clear how these approaches could account for the acculturation process of individuals and communities, especially among the younger generation, as they negotiate the effects of new technology on societal norms of indigenous communities and other communities that they interact with. The work of researchers of multicultural learning environments could prove complementary to indigenous culture responsive design.

4.7.2 Postcolonial computing

In line with the deconstructivist approach to cross-cultural design, Lilly Irani and her colleagues (Irani et al., 2010) propose the postcolonial computing strategy for analysing hybrid design practices that are developing in various centres of design activities around the world. As a reaction to current activities in the discipline of human-computer interaction for the developing world (HCI4D)/Information and Communication Technology for the developing world (ICT4D), the authors seek to shift the development discourse to postcolonial discourse that is "…centred on the questions of power, authority, legitimacy, participation, and intelligibility in the context of cultural encounter…" (Irani et al., 2010, p. 1311). They suggest an analytic approach that applies a generative view of culture, an awareness of the notion of "development" as a historical program inclusive of uneven economic relations, and an examination of cultural epistemologies. This analytic orientation serves as an aid in reconsidering the design practices of engagement, articulation and translation in other cultural contexts.

Employing a "generative view" (Irani et al., 2010, p. 1313) of culture as an analytical position means understanding cultural changes set in motion by the sociocultural phenomenon of globalization combined with the apparent ability of information and communication technologies to circulate cultural concepts around the world. It asks questions such as how technological objects and knowledge practices of everyday life become meaningful through social activities. It posits that people participates in multiple cultures. In this sense the definition of culture encompass ethnicity, nationhood, profession, class, gender, kinship and history. It has been suggested that studies of diaspora communities, for instance, could provide insights into the fluidity of cultural, regional and transnational boundaries as well as into the variability of what the notion of home culture might mean to people's daily life within these communities. The generative view encourages designers to recognize their designs as interventions resulting from conversations with existing cultural practices as well as interventions with transformative effects.

Researchers and designers must be sensitive to the historical and institutionalized power dynamics embedded in the notion of "development" within the context of financial and technological assistance set up between "developed" and "developing" countries as well as between governments, non-governmental organizations, philanthropists, corporations, and supranational organizations such as the World Bank. This serves as a reminder that uneven relationships of economic dependency might lie in the background of technology projects deployed outside of the so-called G8 countries. This factor is rarely analysed, and tends to cause blind spots in the design and development process of artefacts including technology artefacts.

Design practice takes place within a series of economic conditions that makes it possible. Designers and researchers with deep knowledge of the culture for which they are designing might better capture the nuances of their target group's requirements, but the recommended solutions might be ignored or rejected by people in the decision making role if they are not aligned with the existing power dynamics (i.e., aligned to the interest of those who hold the power advantage). Conversely, the target group might reject or ignore a designed solution that is aligned with the uneven dynamics because it fails to address some requirement, inclusive of culture. In both cases from the perspective of creating an artefact that is meaningful for its intended user, the design process either fully or partially fails.

Cultural affordances and constraints surrounding the practice of knowing and telling, of "managing knowledge", must be considered within the context of the design practice. This serves as a reminder that design methods themselves embody principles of knowledge sharing and knowledge representation. In the context of the postcolonial computing strategy, designers should be aware of the intrinsic bias of knowledge management concepts built into design practices. Studies of indigenous communities such as Verran and Christie's (2007) work with the Yonglu suggest that the designer's and the target group's notion of knowledge sharing, from the perspective of what it means to know

something, and what it means to be able to tell it, should be aligned in order to create artefacts that reflect community-appropriate ways of categorizing and organizing information.

Postcolonial computing proposes to abstract design methods into the aspects of engagement, articulation, and translation in order to get analytical leverage on design practices. This abstraction situates the traditional elements of the design process in a context that makes explicit issues of power, history, and epistemology.

Engagement means connecting with the intended users or an application domain in order to understand relevant work or activities. The task of engaging with users is not limited to observation, capturing requirements, and deploying technology. It must also include consciousness of the presence or absence of the context in which Western design methods might or might not work. One must recognize for instance that while the usability testing method have gained authority through and benefited from the elevation of scientific thinking above other forms of creating knowledge in some settings, this context might not be present in other settings. Therefore designers, through mutual engagement with the user, will have to understand what "usability" might entail. This means design methods have to be reframed from their traditional extractive processes such as lessons learned, requirements identified, or knowledge learned, to collaborative processes such as mutual learning wherein users are treated as active participants and partners rather than passive repositories to be mined by designers.

Articulation means studying and communicating the way properties of an application domain are formalized and transformed into requirements for technological support. The notion of articulation entails accounting for unquestioned ontological, political, and economic commitments that are integral to the design of artefacts. Current design methods view knowledge as something to be captured and represented, rather than something to be performed or enacted as it is in other cultures (George et al., 2010; Verran & Christie, 2007). Designers must therefore recognize that articulation as it is realized for example in user-centred design approaches frame and interpret engagement by drawing on traditions of representation that might not be equivalent with knowledge and design practice in other cultures. Establishing perfect equivalence through translation might not be possible.

Translation means communicating *how* the requirements are transformed from statements about an application domain to statements about technology, eventually to specific technology components designed to support the given domain. Design methods that move around the world are interpreted differently, and designs become locally meaningful in different ways. In this sense they are transnationally created and are dynamic. Thus designers cannot assume that design processes and methods are universal.

One can argue that user-centred design methods such as participatory or collaboratory design (Nielsen et al., 2010) already embody the reframing and realignment processes proposed by Irani et al. (2010), and it has been broadly

used in settings outside of the one where it originated (i.e., in Scandinavia); but one should also be aware that participatory design draws authority from a set of discourses of democracy, labour relations and social justice; a context that might not be present in some settings. It has been observed moreover that although user-centred design methodology includes several practices useful for understanding users in a developing world context, it also has major drawbacks particularly when presenting prototypes of the design solution to the user as well as when explaining the broader design process (Maunder, Marsden, Gruijters, & Blake, 2007).

Maunder et al. (2007) suggest that the analysis phase of user-centred design methodology proves useful (for example, in the South African context), but it fails to catch broader environmental and sociocultural factors that affect the design process. They argue that a more appropriate approach not only attempts to analyse users and their environment but also gives priority to developing users' knowledge base and skill sets to enable them to better understand a given technology and its benefits, and thus prepare them to participate in the design process as envisioned by the participatory design method. The underlying rationale is that in many developing world communities and organizations, work and social practices are often not structured around technological solutions, nor are they easily adaptable to accommodate such solutions. Hence people living in these communities are not always able to envision technology-based solutions to perceived needs, or choose between designed solutions, or situate a given technology into their daily lives.

The authors explain that the design approach also must help develop a supportive organizational and social environment for technology use because managerial and leadership processes are often unsupportive of technology solutions. The practice of public technology artefact demonstrations could be employed to attract interested participants who could possibly form a motivated user group as well as act as local informants when addressing design or sociocultural issues that might arise. Development of the users and a supportive environment are baseline components of a realigned participative design approach, and it has to be done early in the design phase. At the stage of representing possible solutions to the users, Maunder et al. (2007) propose using simple, fully functional technology artefacts rather than prototypes in order to show users the obvious utility and benefits of similar functions in the proposed solution. In this way users are able to reflect on the function of the given technology and consider how it might correlate with daily activities without dealing with ambiguities and complex abstract design concepts embodied in a prototype.

The preceding guidelines might strike some researchers and design practitioners as overly concentrating on background processes that take time and attention away from the practicalities of determining design relevant cultural attributes. The alternative however would be to continue deploying prevailing user-centred design tools and techniques that are unsuitable for human-technology interaction design initiatives situated in developing world commu-

nities. Recent analyses of work done in developing world communities imply that lack of attention to sociocultural and environmental effects on the design process itself results in increasing the amount of time required to complete a design initiative, or in derailing the whole project.

4.7.3 Scandinavian collaborative design

Scandinavian collaborative design is premised on the notion of an information technology user as an equal partner and expert collaborating with technology experts throughout the whole design and development cycles. Nielsen, Bødker, and Vatrapu (2010) situate this design approach within the user centric design discipline, but the authors differentiate it from other approaches through Scandinavian collaborative design's emphasis on users as an equal partner and collaborator rather than as a source of information to be mined. The Scandinavian approach is rooted in the Scandinavian culture, drawing its philosophy specifically from the tradition of dialog and negotiations in the labour market. It evolved conceptually from its formulation during the 1970s as cooperation between researchers, developers, users, and union representatives; as a strategy for developing alternative technologies in cooperation with workers in the 1980s; as collaborative design practices in developing multimedia and Internet-based communication in cooperation with the so-called knowledge workers, to its current form as an iterative, participatory design process that aim to produce functional pragmatic designs that respond to people's daily work practices.

Nielsen et al. (2010) argue that a culture historically founded on class struggle, and on the notion of information technology as an arena of power and conflict is implicit in the Scandinavian approach. Thus it shares a sensitivity for the effects on the design processes of inequalities in the socio-economic and power dynamics that has been brought to the foreground by both the postcolonial computing and comparative informatics (see chapter 4.7.4) approaches. The Scandinavian collaborative design approach offers an analytical orientation that aids designers to integrate cultural variables into the design process, through a heightened awareness of the need to engage users early in the design cycle, but it also requires a sensitivity to the possibility that the Scandinavian tradition of democratic dialog when developing new artefacts might not be directly applicable in other cultural settings.

4.7.4 Comparative informatics

Comparative informatics as an emerging analytical approach attempts to trigger heightened awareness of the "uneven surfaces of information and communication technology practices locally and globally" (Nardi, Vatrapu, & Clemmensen, 2011) through systematic examination of the similarities and differences in the information and technology lifecycle (i.e., design, development, deployment, diffusion, use, impact and evaluation) in contexts inclusive of cultures, regions, nations, generations, socioeconomic classes, gender, organizations and technologies. This analytic position is relevant to research within a

critique of power relations existing in the Northern (e.g., G8 countries) as well as Southern (i.e., "developing") locales. The approach calls for critical, empirical analysis of new technologies and ethnographic studies of activities of the target group, in order to pre-empt situations in which assumptions taken for granted in one locale are uncritically exported to another. The authors differentiate the comparative informatics analytical approach through its broader view of power dynamics, and its commitment to accounting for the role of corporations and government institutional interests in the information and technology life cycle.

To sum up: Irani et al.'s (2010) contribution expands the discourse surrounding the cross-cultural technology discourse by situating it in a much broader context that goes beyond issues of usability. Whilst examining socio-economic issues and historically determined power dynamics shaping people's lives could also aid designers and developers in culturally realigning artefacts, the proposed framework provides an arguably more salient way of investigating how new hybrid forms of design and technology are generated through the encounter between different culturally shaped forms of knowledge and practice. A Scandinavian tradition of design through consensus could provide inspiration for methodological considerations, if the target group shares a similar epistemology. Otherwise, it will require an explicit search for a hybrid design practice. Nardi et al. (2011) have suggested, however, that a postcolonial perspective is not adequate in capturing the important role of other cultural, historical circumstances such as current global political activity. One could add to this critique the question of whether a postcolonial orientation can capture the in-country power dynamic that is partly due to the postcolonial experience. That is, it is not clear how the analytical tool could address issues and effects of systemic corruption on development projects.

4.8 Life-based design

Life-based design shifts the spotlight in technology design from usability problems to enhancing people's quality of life. The life-based design process consists of (a) studying a given group's form of life; a form of life is composed of domains of actions characterized by rule-following actions, e.g., daily activities, routines and habits, as well as the facts and values of the form of life; (b) determining the design-relevant attributes; (c) deriving technology supported actions from the attributes; (d) analysing design alternatives; and (e) constructing design requirements. The expected results of this process are product and service concepts. The process enables designers to specify the requirements for concept development.

If one uses life-based design as a paradigm for conceptualizing designs, one needs to understand the context—that is, the form of life in which the artefact will be applied—to formulate relevant attributes necessary for design conceptualization. In relation to doing this task with the ambition of innovating artefacts with universal applications—that is, it can be applied with minimum

friction in any cultural context—one needs to understand the cross-cultural factors that affect the attributes that one is searching. One needs to understand both the universal and culture-specific factors.

While life-based design provides the necessary holistic paradigm for design projects in general and human-technology interaction design in particular, using the form of life concept as the main component for cross-cultural human-technology interaction design could be problematic. One cannot assume that a certain form of life for one cohort in one culture has equivalent meanings for an equivalent or similar cohort in another culture (Peng, Nisbett, & Wong, 1997). Finding commonalities in forms of life in various cultures will be as difficult as finding what is common to all language games. As Ludwig Wittgenstein observed, if we "'*look and see*' (emphasis in original) whether there is anything common to all forms of life, we will not find it; instead we will find a whole series of similarities and relationships. The point here is that establishing equivalence in the meaning of forms of life will be a tall order indeed. …[A]s in spinning a thread we twist fibre on fibre. And the strength of the thread does not reside in the fact that some one fibre runs through its whole length, but in the overlapping of many fibres." (Wittgenstein, 1967, pp. 31-32). Life-based design's inherent weakness can be mitigated through application of a convergent research strategy.

4.9 Summary

The various approaches reviewed in this chapter contribute to a convergent approach, but all need complementary approaches in order to strengthen their applicability across different projects and domains of action. There is a need for more qualitative—for instance ethnographic—studies (Clemmensen & Roese, 2010) to envision needs for new technology as well as to aid in realignment of existing technology.

Given the current state of human-technology interaction research, one can infer a growing recognition of the notion of cultural fit in the design and development of technology artefacts, and recognition of the need for an integrative approach to studying people's needs, variance in thinking, feeling, and acting with technology. The majority of the literature reviewed highlights the dimension of cultural fit in human-technology interaction conceptualized as cross-cultural usability problems, but the dimension of integrated theoretical frameworks inclusive of cultural factors has been underemphasized. There is paucity moreover in integrated methods that could help designers deal with a given problem niche, which is affected by culture, prior to the concept development stage. There is also paucity in human-technology interaction design research concerning cultures located in developing nations, and in multicultural environments including cohorts with disabilities.

All the current approaches reviewed make important contributions toward a culturally responsive human-technology interaction research and design.

However, all require complementary approaches to fill inherent gaps in the lack of emphasis on people's form of life, or the absence of an explicit integrative cultural theory to support identification and mapping of design relevant attributes. Filling the former gap is salient to envisioning people's needs for new technology; employing integrative theories can guide the research strategy and methodology. The time is ripe for a convergence in the discourse of human-technology interaction research.

5 PATH TO A THEORETICAL MODEL OF CULTURAL HTI DESIGN

As has been argued throughout the present work, culture and technology are intertwined phenomena indispensable to the development of human cultures, and equally indispensable to human experience. They are mutually-, or co-determined. Undoing this relationship of mutual specification means one would also have to undo the human forms of life as we know them. Current research literature already points to the crucial functions of cultural factors in the creation of technology artefacts. This situation suggests that research in technology is converging toward a common point, and that point is culture. With regard to human-technology interaction research, investigators approach this enterprise from frames of usability, user experience, emotions and affect, semantics, postcolonial experience, gender, indigenous epistemology, and other approaches while at the same time discovering that concepts deployed in the frameworks are subject to cultural variance. Hence there is a need for explicating cultural factors and their effects before one can use research results to design relevant attributes.

This chapter attempts to theoretically specify four facets of a cultural human-technology interaction theoretical model: (1) the antecedents of culture, (2) the cognitive and behavioural indicators or markers of the motivational goals for interaction, (3) the motivational goals and values orientation for the interaction, and (4) the frame of reference for evaluating goals and values. The rest of this chapter continues with a review of alternative theories, and then elaborates the development of a theoretical framework.

5.1 Current theories

Previous works in cross-cultural ICT design situate the applicability of cultural theories and psychology methods in the organizational work context. They include cross-cultural usability testing of information systems and management

of such systems within organizations. Conceptualizing culture in terms of values, coupled with using national culture as a proxy, seems to be the dominant approach to studying culture as a variable in explanations of human-technology interaction (Clemmensen & Roese, 2010). But several domains remain unaddressed. For instance D. P. Ford, Connelly, and Meister (2003) observe that most research focuses on cultural issues related to management of information systems, while analyses of cultural issues related to information system usage, operations and development remain lacking. Several teams of investigators have responded to the call to fill the gaps in theory development.

Elena Karahanna, J. Roberto Evaristo, and Mark Srite have proposed a theory of variability in the effects of the levels of culture on individual behaviour in the context of organizational work (Karahanna et al., 2005). The authors argue for a conceptualization of culture as a multi-layered construct manifesting in subjective cultural values espoused at the supranational, national, organizational, and group levels of organization. Subjective cultural values are defined as the sum of the weight of influence of a specific level of culture on behaviour, and the specific value set subsumed by a specific level of culture. The relative magnitude of influence of a specific level of culture is correlated to the content and characteristic of a given behaviour, that is, whether it is predominantly socially oriented or task oriented.

Karahanna et al.'s (2005) framework provides an important theoretical extension and practical support for integration and convergence in the human-technology interaction field for it enables a more nuanced view of culture's role in organizational behaviour.

Leidner and Kayworth (2006) put forward the theory of information technology culture conflict, to explain potential value conflicts that might emerge in the development, adoption, use, and management of information technology. They argued for the notion of *cultural fit* in the context of technology adoption and diffusion; that is, groups adopt a given technology if their cultural values fit the values embedded in the technology, or values associated with its development. Values underlie human practices (including the practice of design) that are supported by information technology. It follows that *information* and *technology* associated with information and communication technology are embedded with values (Feldman & March, 1981; Leidner & Kayworth, 2006; Scholz, 1990).

A key implication for the field of human-technology interaction from Leidner and Kayworth's work is the notion that research and design are not value neutral, hence they are not culture neutral. This implication is consistent with observations by Young (2008) and Eugene et al. (2009), and support the call for foregrounding culture's relation to HTI relevant phenomena in order to make explicit cultural biases embedded in the research and design processes, as an integral part of conceptualizing and designing culturally responsive artefacts.

Kappos and Rivard (2008) provide three perspectives of culture—integration, differentiation, and fragmentation—to integrate researchers' divergent conceptualizations of culture concerning the extent of consensus among

members of a given group regarding the interpretations of, and the meaning given to cultural manifestations. They concluded that culture (a) influences the development process; (b) moderates the relationship between the development process and the characteristics of the information system; (c) moderates the relationship between the information system characteristics and usage process; and (d) accepts influences from information systems.

Kappos and Rivard's important contribution to the drive for integration and convergence in human-technology interaction research and design is a model supporting systematic causal description of culture's main roles in various information systems (IS) processes, hence allowing further granularity to the view of complex relations between cultural and process variables salient to conceptualization and design of human-technology interaction.

The cultural model of usability theory proposed by Torkil Clemmensen (Clemmensen, 2009) provides an important contribution to the movement toward integrative frameworks for human-technology interaction design through realignment of the definition of usability as a culturally determined construct. The realignment serves to ease the empirical study of usability across cultures. It also makes empirical measurements of artefacts more meaningful in culture specific as well as multicultural usability evaluations.

There is, however, a contradiction within the theory set into motion by the second and third considerations outlined in the theory (see also chapter 4.2.4.2). According to Clemmensen (2009, pp. 418-419), the second consideration broadens the current standard definition of usability in order to integrate people's culturally determined cognition and cultural models to the conceptualization of usability. This realignment of definition has three purposes: (1) to provide a cultural basis to the interpretation of what it means to interact with an artefact, hence making the application of usability more meaningful to a particular culture (i.e., non-Western), and in multicultural contexts; (2) to posit usability as a universal construct, thereby enabling a more meaningful measurement of usability across cultures; and (3) to remind evaluators to go beyond the standard measurement using the criteria of efficiency, effectiveness, and satisfaction. Hence the second consideration serves to pan-culturally inform what was considered a (Western) culturally biased notion. The third consideration posits that internal models (i.e., cultural models) of technology artefact usage consist of goals, actions and emotions, and *constitute effectiveness, efficiency, and satisfaction* [emphasis added] of interacting with an artefact, and the content as well internal relations between these criteria might vary across the world's population.

The theory therefore treats the status quo's standard criteria for usability as equivalent to whatever culturally determined goals, actions, and emotions (i.e., non-standard criteria) are present in the evaluation situation. Hence whilst proposing to neutralize the bias embedded in standard usability methods, the theory nevertheless leaves it intact and in place. The current standard criteria for usability still serve a useful purpose to cultural usability within the contexts from which they originated and found meaningful application (i.e., the U.S. and Europe). But they cannot be considered equivalent measures across cultures

(Winschiers & Fendler, 2007). Notwithstanding the internal contradiction, the cultural model of usability theory is an important milestone.

The preceding theories make important contributions to converging on a cultural theory of human-technology interaction. The present work proposes another contribution toward this end.

5.2 Guiding principles

As stated in chapter 1.7, the present work aims to contribute to efforts of narrowing the gap in human-technology interaction research by developing a theoretical understanding of the complex relations between human forms of life, culture and technology, and deriving from it an extension to a holistic culturally responsive human-technology interaction research strategy. The problems specified in chapter 1 simultaneously constitute theoretical and methodological issues, and the present work addresses both issues. However, it is important to re-emphasize the focus of the present effort: to support the early-stage conceptual processes of human-technology interaction design. Hence in theorizing the preconditions for potential needs relevant to conceptualizing new technology, it is submitted that dissatisfaction with constraints triggers desire for a designed technology solution.

It is suggested that in addition to its function as a medium for transmission of viable practices contributing to the continuation of the human species, the development of culture is linked to a perceived dissatisfaction with constraints exerted by the physical laws of nature, that is, constraints to fulfilment of a compelling tendency to action. Furthermore, sociocultural practices, as by-products of human reaction to natural affordances and constraints, could and do act as constraints to human actions (Schwartz, 1992; Schwartz, 1999). Thus dissatisfaction with these constraints also triggers the desire for new practices that overcome or modify them. Necessity is indeed the mother of invention. The construct *necessity,* as it is used in the context of the presentation on constraints and the human perception of them, deserves clarification.

Necessity, in the context of human experience and being, constitutes the drive for *well-being*. Unlike other animals, humans perceive survival and well-being as inseparable components of the drive for being. They are two sides of the same coin. Hence a definition exclusively contextualizing necessity to matters of survival is inadequate for describing the human experience of necessity in the context of constraints, for it does not differentiate the human agency or will to *survive in well-being*. One could readily appreciate the ambiguity of survival as a necessity, in considering the equally strong human will to die. (Ortega y Gasset, 1972/1983).

The significance of culture to human experience lies in its form/function as "a by-product of the evolution of complex neural circuitry" (M. Harris, 1979, p. 122), and as a repository of the various emergent means for well-being, that is, in coping with the physical, chemical, biological and ecological constraints to

human actions, and as the means for encoding the practices and technology that has developed through a history of structural coupling with the environment.

The construct of structural coupling is due to Maturana and Varela (1980, pp. 78-82). Structural coupling is the term for structure-determined and structure-determining interactions of a living organism conceptualized as a self-maintaining system, with either its environment or another organism. This process connotes both coordination and co-evolution. During the course of interaction (i.e. structural coupling), each participating unity or system is a source and a target of perturbations in relation to each other. The participating systems reciprocally serve as sources of compensable perturbations for each other. These are compensable in the sense of an existing range of compensation bounded by limitations beyond which each system ceases to be a functional whole (that is, the organism dies), and each iteration of the reciprocal interaction is affected by the one before.

As previously explained, the theoretical principles underlying the present path to a theoretical understanding of a culturally responsive human-technology interaction design draw on elements from cultural materialism, open systems view in the general systems theory, embodied cognition, and cultural psychology. The proposition regarding dissatisfaction with constraints subsumes the following principles.

5.2.1.1 Basic principles

5.2.1.1.1 Principle 1: Culture as an open system

Culture is foremost an open system maintained by a continuous interaction with the affordances and constraints of the environment (i.e., natural, societal, institutional). It is affected by ecological and physical factors—i.e., geography, climate, and natural resources (e.g., Berry et al., 2011, p. 14; M. Harris, 1979, p. 57; G. H. Hofstede, 1980/2001, p. 10), evolutionary processes (e.g., Buss, 2001; Tooby & Cosmides, 1992), social factors (e.g., F. R. Kluckhohn, Strodtbeck, & Roberts, 1961, p. 11; Rokeach, 1973; Schwartz, 2013, p.2) and biopsychological factors (e.g., C. Kluckhohn, 1951/1952, p. 409-410).

5.2.1.1.2 Principle 2: Universal antecedents of culture

The antecedents of culture specified above are considered universal. That is, all human societies have a universal need for the following (M. Harris, 1979, p. 51):

(a) Need to deal with problems of production (i.e., need to satisfy basic subsistence requirements). [Ecological, Biological].

(b) Need to cope with the problem of reproduction (i.e., to avoid destructive increases or decreases in population. [Ecological, Biological].

(c) Need to maintain secure and orderly behavioural relationships among society's groups, and with other societies. [Social].

Culture's antecedents (i.e., when culture is treated as a dependent variable) are summarized in Table 3.

TABLE 3 Factors that influence culture.[18]

Culture's antecedents when culture is treated as a dependent variable.		
Ecological	**Biological**	**Social**
Geography (Berry, 1971)	Aggregate temperament (Matsumoto & Juang, 2008)	Population density (Harris, 1979)
Climate (Berry, 1971)	Aggregate personality (Matsumoto & Juang, 2008)	Affluence (Hofstede, 1980/2001; Schwartz, 2013)
Natural resources availability (Harris, 1979)		Technology (Harris, 1979)
		Type of government (Hofstede, 1980/2001)
		Institutions (Schwartz, 2013)
		Media
		Sociocultural history
		Religion

5.2.1.1.3 Principle 3: Universal consequents of culture

Since culture is a response to the affordances and constraints of the environment, and given the fundamental human need for survival, it follows that culture serves as a framework that people use to choose values and actions from a field of alternatives that could maximize the benefits from usage of limited resources needed for survival. This view is consistent with the Brunswikian lens model (Brunswik, 1955) of human psychology to the extent that the cultural lens enables focusing of human perceptual processes to an apex of significant meanings. As the late professor Ulric Neisser observed, "Perceivers do not go beyond the information given, but cultures go beyond the elementary contingencies of nature to make additional information available. The rules of chess do not control the master's perception; they make it possible by giving him something to perceive" (Neisser, 1976, p. 181). The consequents of culture are summarized in Table 4.

Marvin Harris posited four universal sectors of sociocultural systems: (a) the etic behavioural infrastructure, (b) the etic behavioural structure, (c) the etic behavioural superstructure, and (d) the mental and emic superstructure. The components and their consequents are summarized in Table 5. Cultural materialist theory gives strategic priority to etic and behavioural conditions and processes, "…but it does not deny the possibility that emic, mental, superstructural and structural components may achieve a degree of autonomy from the etic behavioural infrastructure" (M. Harris, 1979, p. 56). Cultural materialistic typology defines sociocultural components as follows.

> "*Mode of Production*: The technology and the practices employed for expanding or limiting basic subsistence production, especially the production of food and other forms of energy, given the restrictions and opportunities provided by a specific technology interacting with a specific habitat". (M. Harris, 1979, p. 52). [Italics in the original].

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18 Adapted from Matsumoto & Juang, 2008, pp. 13-14, 23.

"*Mode of Reproduction*: The technology and the practices employed for expanding, limiting, and maintaining population size". (M. Harris, 1979, p. 52). [Italics in the original].

"*Domestic Economy*: The organization of reproduction and basic production, exchange, and consumption within camps, houses, apartments, or other domestic settings". (M. Harris, 1979, p. 52). [Italics in the original].

Political Economy: The organization of reproduction, production, exchange, and consumption within and between bands, villages, chiefdoms, states, and empires". (M. Harris, 1979, p. 53). [Italics in the original]

"*Behavioral superstructure*: universal recurrence of productive behavior that leads to etic, recreational, sportive, and aesthetic products and services" (M. Harris, 1979, p. 52) [Italics in the original].

"Symbolic-ideational superstructure" (M. Harris, 1999, p. 141): the symbolic-ideational processes "running roughly parallel to the etic behavioral components" (M. Harris, 1979, p. 53).

TABLE 4 Individual traits influenced by culture.[19]

Culture's consequents when culture is treated as an independent variable.		
Ecological	**Biological**	**Social**
Values (F. Kluckhohn et al., 1961; Rokeach, 1973)	Temperament	Values (G. Hofstede (1980/2001; F. Kluckhohn et al., 1961; Schwartz, 2013)
Attitudes	Personality (Schwartz, 2013)	Attitudes
Beliefs	Behaviour	Beliefs
Behaviours (Berry, 1971)		Behaviour
Opinions		Communication style (Hall, 1959/1973)
Worldviews (Nisbett et al., 2001)		Opinions
Norms		Worldviews (Geertz, 1973)
		Norms

5.2.1.1.4 Principle 4: Culture as a dynamic system

Culture is a dynamic system, which might reach a steady state—i.e., remains temporally constant, but its processes are in a state of flux; hence the cultural system never comes to rest (e.g., M. Harris, 1979, pp. 60-61, 134; Schwartz, 2006, p. 139; Tooby & Cosmides, 1992, p. 47).

An appreciation for the significance of culture to human experience necessitates acknowledgement of a basic fact of human life and experience: human actions are subject to the constraints of survival and reproduction throughout the evolution of human coupling with the environment (Buss, 2001; M. Harris, 1979; Tooby & Cosmides, 1992). In the present work, the usage of the term *constraint* is more akin to the term *coercion* to emphasize the notion of *mutually or jointly compelled action* that is characteristic of the continuous coupling interaction between humans and their environment. These constraints could be further sub-divided under the rubrics of ecological, biological, chemical and physical constraints. Cultures developed as a by-product partly of human evolution, and partly of the continuous history of human interaction with the environment.

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19 Adapted from Matsumoto & Juang, 2008.

TABLE 5 Sectors of sociocultural systems.[20]

Cultural materialistic view of culture's consequents.					
I-Infrastructure (mode of production and reproduction)		**II-Structure (domestic/political economies)**		**III & IV-Superstructure**	
Behavioural (etic)	**Mental (emic)**	**Behavioural (etic)**	**Mental (emic)**	**III Behavioural (etic)**	**IV Mental (emic)**
Mode of production:		*Domestic economy*:			
Technology of subsistence	Subsistence lore, ethnobotany, ethnozoology, religion, taboos, magic	Family structure	Kinship, political ideology, ethnic ideology, national ideology, religion, taboos, magic	Art, music, dance, literature, advertising	Symbols, myths, philosophy, epistemologies, aesthetics, ideologies, religion, taboos, magic
Techno-environmental relationships		Domestic division of labour		Science	
Ecosystems		Domestic socialization, enculturation, education		Rituals	
Work patterns		Age and sex roles		Sports, games, hobbies	
		Domestic discipline, hierarchies, sanctions			
Mode of reproduction:		*Political economy:*			
Demography		Political organizations, factions, associations, corporations	Kinship, political ideology, ethnic ideology, national ideology, religion, taboos, magic		
Mating patterns		Division of labour			
Fertility, natality, mortality		Taxation			
Nurturance of infants		Political socialization, enculturation, education			
Medical control of demographic patterns		Class, caste, urban and rural hierarchies			
Contraception		Discipline, police/military control			

[20] Adapted from M. Harris, 1979, pp. 52-54.

5.2.1.1.5 Principle 5: Culture as interface

Culture is an interface between people and nature. In the previous discussion of the significance of culture to human life and experience, it has been explained that culture—or more precisely the practices inclusive of technology, and the ways of being and thinking—came about as a by-product of human evolution and the continuous history of human interaction with the environment, with nature (Buss, 2001; Tooby & Cosmides, 1992). Human cultures evolved as part of the human drive to find a balance between coping with the exigencies of natural laws governing reproduction, and the production, and consumption of energy (M. Harris, 1979; M. Harris, 1999). Hence culture mediates and shapes human actions, cognition, experiences and worldviews[21] (Adamopoulos & Lonner, 2001; Koltko-Rivera, 2004; Mishra, 2001).

Consider Figure 2 to further examine this mutual determination. The area denoted by *A* represents the nature-culture-human relation. It also represents the area wherein one can group the observable human domains of actions and describable experiences that are salient to the analysis of human interaction through technology.

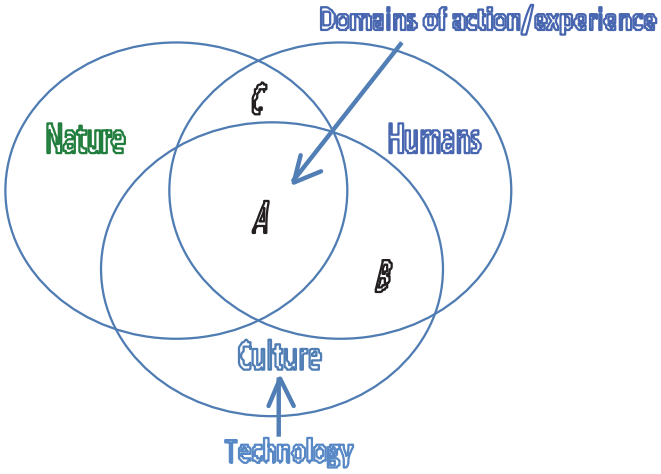

FIGURE 2 Culture as interface to nature.

The term *domain of action*[22] (Winograd & Flores, 1988) represents the myriad activities that contemporary people perform throughout the course of their daily life as well as their life cycle — that is, sleeping, waking, cooking, having meals, washing, working, playing, performing religious or secular rituals, traveling, having a lovers' tryst, and so forth. In other words, activities that consti-

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21 Cf. "The mass of learned and transmitted motor reactions, habits, techniques, ideas, and values—and the behaviour they induce is what constitutes culture" (Kroeber, 1948, p. 8 as cited by H. Harris, 1979, p. 179). "Culture could be defined as the interactive aggregate of common characteristics that influence a human group's response to its environment" (Hofstede, 1980/2001, p. 10).

22 See concept of "behaviour spheres" (F.R. Kluckhohn, Strodtbeck, & Roberts, 1961, p. 3).

tute the cycles of interaction between humans, their environment, each other and other organisms. The term activity represents action constituting physical, physiological and mental motion. A domain of action constitutes communication (verbal and non-verbal), material, social, temporal, spatial, and other components. The domain of action provides the context of the contents of human interaction.

Culture does not mediate all the dimensions of human interaction with nature, and this constraint is represented by area *C*; for example culture does not specify the fact that people breathe the same air. On the other hand, certain culturally-influenced breathing practices such as yogic Ujjayi breathing specify *how* one can breathe the air (Lathadevi, Maheswari, & Nagashree, 2012; Carter et al., 2013). Consequences of technology such as air pollution can also determine the quality of the air people breathe. There are certain dimensions of the human-culture relations that do not concern nature. For instance, nature does not react to how humans experience the spatio-temporal dimension of reality; nor does it care whether an individual is beautiful or ugly, young or old, moral or immoral, religious or non-religious, or prefer one religion rather than another. Nature, on the other hand, reacts to intensification of production and consequent depletion of natural resources (cf. M. Harris, 1979, p. 57).

It is important to note moreover that culture defined as the socially learned ways of living circumscribing all aspects of social life, including both thought and behaviour, limits its use in categorizing variability in human factors relevant to human-technology interaction analysis and design. For instance, culture, as has been defined, is not the most useful construct for organizing data on the diversity and variability of the human characteristics that one examines through anthropometrical studies (see presentation in chapter 2.4). Organizing data on the dimensions of the human body are better served by the construct *race*, defined as the major divisions of humans having distinct physical characteristics, in conjunction with biological, genetic, and environmental factors affecting the biophysical structure of the human body. This is not to deny the complex interactions between nature, culture and race. For example food diets, which are partly culturally determined, could affect the development of the human body (Bogin et al., 2002; Bralic, 2011). However while cultural variability in diet types might have explicative relevance to cohort-level variability in mobility of the skeletal system or variability in muscle strength and working capacity, it has limited practical usefulness to the translation of skeletal and muscle characteristics-related requirements into an operational users' requirements.

5.2.1.1.6 Principle 6: Differentiation principle

"Differentiation" (Bertalanffy, 1981, p. 117) articulated as transformation from a homogenous to a heterogeneous condition is ubiquitous in culture (cf. evolution of hominid culture in M. Harris, 1979, p. 134).

5.2.1.1.7 Principle 7a: Primacy of infrastructure principle

Following principle 3 with regard to the strategic priority asserted for etic behavioural processes and conditions, cultural materialistic primacy of the infrastructure principle is assumed to be applicable to the present theoretical development. The rationale for giving primacy to the infrastructure sector during the search for causal explanations of cultural phenomena is due to the sector's proximity to the boundary between culture and nature (see
Figure 3). The infrastructure sector is the primary interface, hence it is posited that effects of cultural manifestations in the sector exert influence on phenomena at the structure and superstructure sectors.

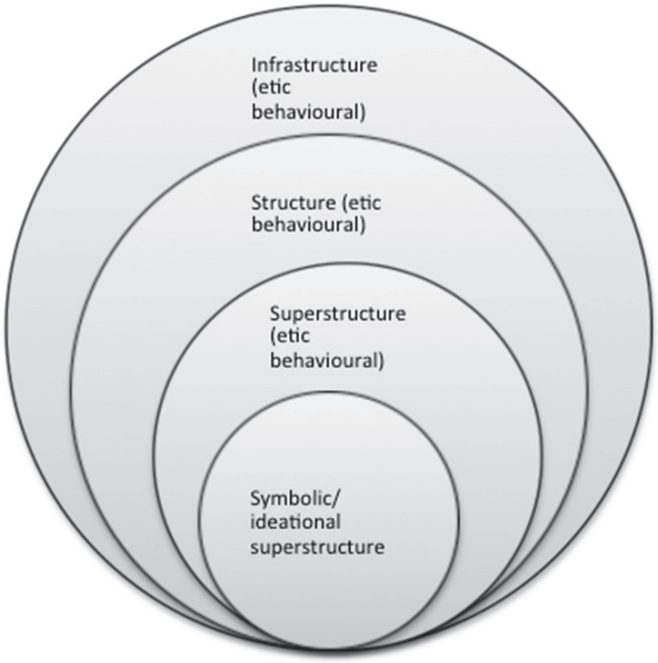

FIGURE 3 Primacy of the infrastructure principle.[23]

[23] Adapted from M. Harris, 1979, pp. 52-57.

Strategic priority given to the infrastructure sector also rests upon the human inability to change physical laws exerted by nature upon humans as biological forms (M. Harris, 1979, pp. 56-57). As M. Harris (1979) explains, humans need to expend energy to get energy and other life-sustaining materials. Our ability to have children surpasses our ability to obtain energy for them. The need to eat is universal among humans, but the type of food, and the quantities that can be eaten vary according to the habitat and the available subsistence technology. Sex drives are also universal, but the reproductive results vary according to availability of contraceptive technology, perinatal care, and the treatment of infants. In other words, these examples of needs and drives are subject to physical laws that cannot be changed. One can only attempt to find a balance in dealing with the exigencies of these natural laws, that is, a balance between reproduction, and the production and consumption of energy.

One can therefore trace the causal chain of the evolution of human cultures to the imperative to strike such a balance. Sociocultural practices and technology have been developed to overcome or modify these constraints. (M. Harris, 1979, pp. 56-57). The primacy of infrastructure principle implies hierarchical, dynamic, predictable relationships between the sectors (see Figure 3 and Figure 4).

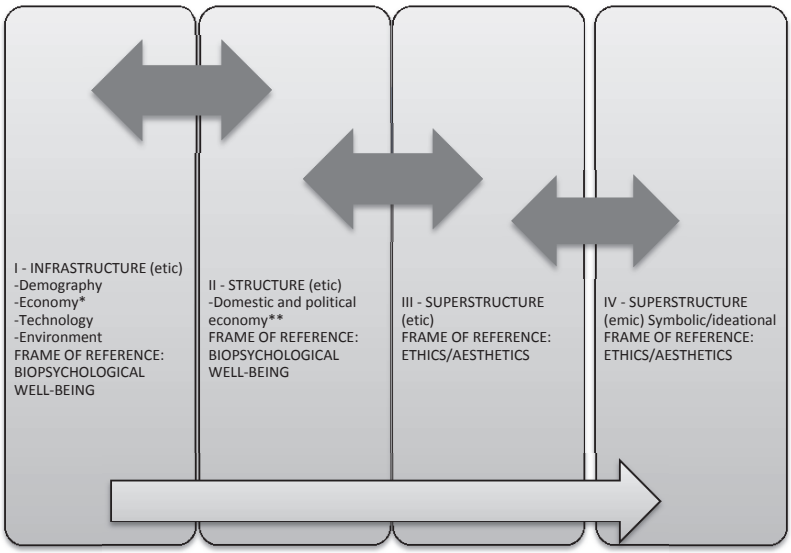

FIGURE 4 Causal model: effects of innovations in the different sectors.[24]

The infrastructure sector is situated as the foundation layer, and closest in proximity to the boundary with the environment. The structure is at the middle layer. The superstructure is at the topmost layer and is situated farthest from the boundary with nature. The primacy principle suggests changes in the infrastructure sectors are largely due to changes in a human population's rela-

[24] Adapted from M. Harris, 1979, pp. 141-152.

tionship to the environment. "Moreover, cultural materialism holds that, over time, changes in a society's material base will lead to functionally compatible changes in its social and political institutions (structure) and its secular and religious ideology (superstructure). (Murphy & Margolis, 1995, p. 2).

In Figure 4 the term economy in the infrastructure sector represents the predominant production practices in a given society—e.g. foraging, irrigation, agriculture, and industrial factory production (M. Harris, 1999, p. 142). The present author adds information production—e.g. as manifested in ICT and media production. In the structure sector, economy represents the social relations of production. These relations are "…governed by institutions such as private or communal property and wages or other forms of compensation and exchange" (M. Harris, 1999, p. 142).

5.2.1.2 Structural relations of sources for causal explications

As a source for theorizing causal relations between cultural factors and human-technology interaction processes, cultural materialism's primacy of infrastructure principle is incorporated in the development of the theoretical model, in order to specify a starting point for searching explications of cultural similarities and differences in cognitive, affective, and behavioural phenomena relevant to human-technology interaction processes in the context of a given domain of action, and to specifying the relations between sources for potential causal explanations (see Figure 4).

Most of the empirical studies reviewed in connection with the present work implicitly assume that differences in the variable of interest (e.g., cognitive style and communication style) are due to cultural differences. In this sense Vatrapu's (2010) critique of cultural theory's tautological explanations of human-technology interaction relevant phenomena is supported. Thus it is suggested that adoption of the primacy of infrastructure principle could support the systematic search for parsimonious causal explanations of human-technology interaction phenomena, as an alternative to assuming cultural differences by employing in studies a cultural variable of interest as covariate to the human-technology interaction variable being examined (cf. critique of cross-cultural psychology unpackaging studies in Fischer & Schwartz, 2011, p. 1139).

5.2.1.2.1 Principle 7b: Reference frame specification

Adaptation of the primacy of infrastructure principle in the present work specifies the frames of reference to represent the cultural materialist rubrics as follows: biopsychological frame (i.e., fulfillment of biopsychological needs) refers to infrastructure and structure; ethics and aesthetics refer to superstructure. While the principle implies a hierarchical structural relationship, it is suggested that a circular interdependent structural relations would better describe human phenomena of interest to human-technology interaction research (see Figure 5). The central issue in the search for explanations of cultural similarities and differences is whether sociocultural selection happens at the

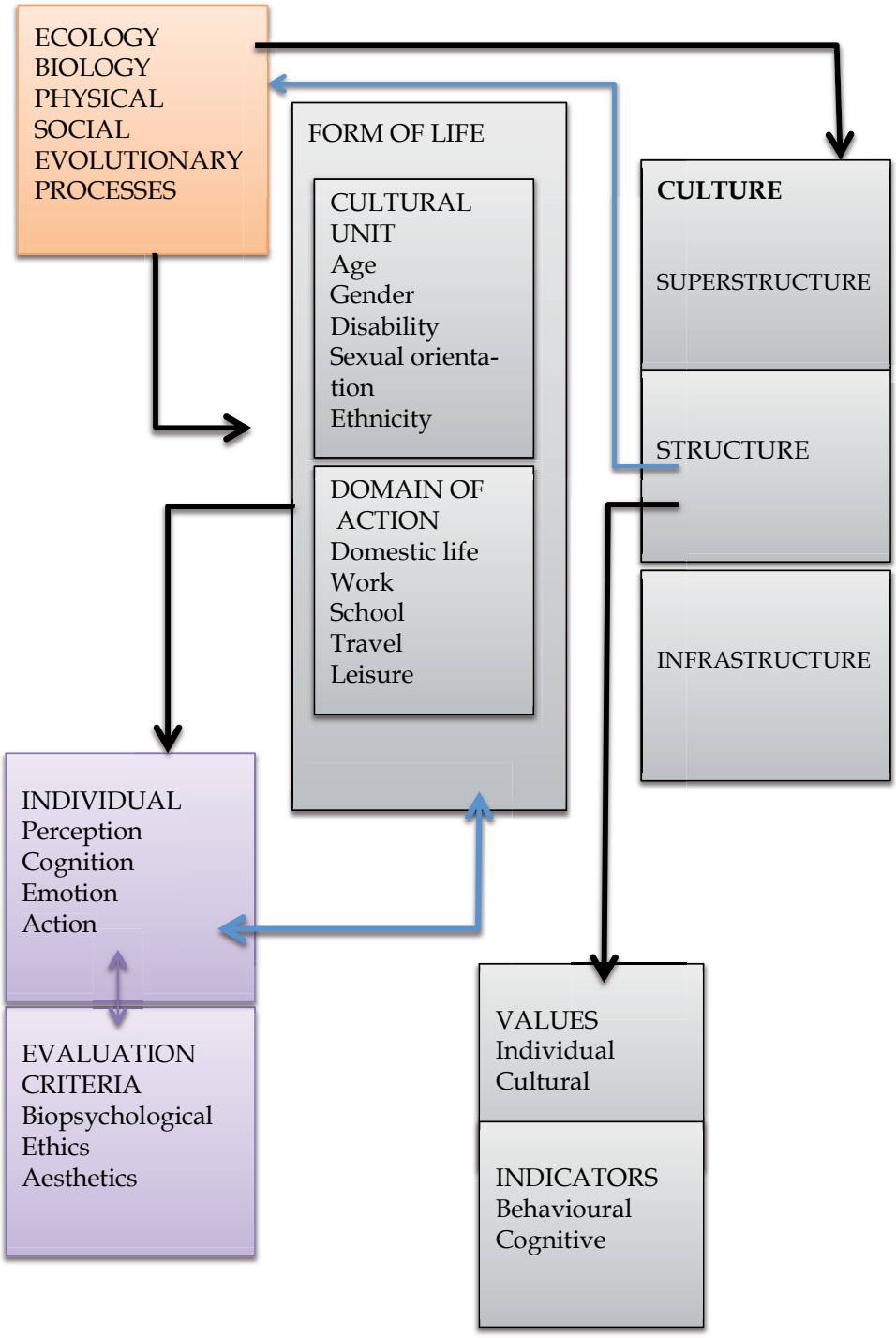

FIGURE 5 Structural relations causal model.

infrastructure or another sector of a cultural system (M. Harris, 1999, p. 141). The primacy of infrastructure principle (M. Harris, 1999, pp. 142-143) holds that innovations that enhance the efficiency of production and reproduction (infrastructure sector)—that is, processes that sustain health and well-being, and satisfy basic human biopsychological needs—are likely to be selected for and propagated, even if there are contradictions between them and pre-existing aspects of the structural (e.g., domestic and political economies) and symbolic-ideational (e.g., meaning systems) sectors of the system. Resolution of incompatibility between an infra-structural innovation and the pre-existing features of the other sectors of the system will predictably involve substantial changes in those sectors.

Conversely, innovations of a structural or symbolic-ideational type are likely to be selected against if there is any remarkable incompatibility between them and the infrastructure. Innovations are continuously tested for their contribution to well-being. The cost and benefits of innovations apply to the well-being of entire populations or to groups, some of which might have conflicting interests in the innovations' consequences. Amongst groups with conflicting interest, selection for or against a given innovation depends upon each group's ability to exert its relative power to advance its interests.

5.2.1.2.2 Principle 7c: Dysfunctional innovations

Whilst the infrastructural cost-benefit calculation can be employed to explain the consequent selection for or against an adaptive innovation, it cannot explain instances in which innovations are adaptively neutral—i.e., warranting no remarkable positive or negative consequences, or dysfunctional—in the sense that they diminish the well-being of a group or an entire population (M. Harris, 1999, pp. 145-147).

In information and communication technology vernacular, peer-to-peer (p2p) file sharing techniques applied to digitized versions of commercial music and films illustrate the preceding principles. Peer-to-peer software enhanced the efficiency to reproduce and redistribute artefacts, and was widely adopted and propagated particularly by a technology savvy group, although its usage conflicted with pre-existing social norms based on the concept of economic rent (Carlsson & Gustavsson, 2001; Lessig, 2004; McCourt & Burkart, 2003). The technology arguably enhanced the well-being of its proponents, butit concurrently reduced another group's (primarily music and film distribution organizations) ability to extract economic rent (Schwartz, 2003). The resolution of this incompatibility, which came only after remarkable exertions of relative power by the opposing group, caused substantial changes in the sales and distribution of music and films (Lessig, 2004; S. Smith, 2003). The software's proponents ceased using it according to the original motivation of sharing cultural artefacts at little or no cost, while its opponents assimilated the underlying technology into their sector of the system.

In terms of adaptively neutral innovations, one can say that the emergence and proliferation of virus software is an example of a dysfunctional innovation in the information and communication technology domain. It is questionable whether anybody benefits from the selection for and propagation of this artefact, although one could argue that its introduction into the Internet-connected ecosystem spawned counter-innovations in anti-virus software and related services.

Why cultural materialism and the primacy of the infrastructure? The combined notions provide a framework for examining human domains of action at multiple levels (i.e., infrastructure, structure, superstructure). Cultural materialist theory provides an integrative circular (feedback) system-based theoretical and analytical frame. It could guide the research strategy and methodology for extracting data from domains of action about people's needs (i.e., ideational and behavioural) for technology. Giving primacy to infrastructure phenomena provides parsimony in arriving at explanatory theory. If one starts at the superstructure (specially emic) or structure, one might miss a root causal account. This is a very pragmatic reason, of course, because if one accept the causal chain infrastructure→structure→superstructure (with circular movement/feedback) one can start at any level of the analytical frame provided that one checks for possible causality at the other levels also. The circularity of cultural materialist strategy is compatible with the circularity of autopoiesis and embodied action (cognition).

A system-oriented cultural materialist theory of technology assists in understanding an observed paradox related to people's use of technology artefacts: individuals want to be part of a group and they conform to the group's norms, but they also want to preserve their individuality. The construct of individualism-collectivism has been used to differentiate people's ideas and behaviour, but not much is known about why individuals diverge from the norms, or why they diverge in ways that are still implicitly acceptable relative to the norms (Witt, 2010). People seem to gravitate to artefacts that enable them to act and achieve goals that conform to as well as break free from sociocultural constraints. Personal electronic devices such as mini-music players and mobile phones, and mediating technology such as social networking sites are examples of artefacts that fulfil people's need to reconcile conflicting values.

Whilst culture mediates mental and physical interaction with technology, technology and its usage modify behaviour and mental models and attitudes.

5.2.1.2.3 Principle 8: Semiotic construction of technology

The meaning of technology is socioculturally determined (Figure 6). All human artefacts derive their meaning or meanings through socioculturally agreed definitions (Bloomfield & Vurdubakis, 1994; Winner, 1992). Teenagers living in Finland, for instance, might define a mobile phone as an object containing their life. It constitutes a database of all the people they regard as important and with whom they keep regular contact. It is a source of entertainment, for it provides them with music to listen to, videos to watch, and games to play (Oksman & Turtiainen, 2004). Teenagers, particularly those belonging to the underprivileged class, living in Kenya might also define a mobile phone as an object containing their life. It contains the names of all the people in their neighbourhood to whom their fathers or mothers rent the very same phone on a regular basis. This micro-rental activity is the main source of their family's income. It might also serve as the main means through which gainfully employed relatives living in bigger cities send money to buy food for a day or two (Hellström & Tröften, 2010). The sociocultural meaning(s) of mundane technology such as trams or streetcars, or overpasses (see presentation in chapter 3) can vary depending on the cultural lens through which they are viewed and experienced.

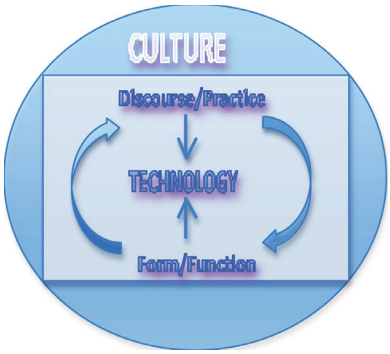

FIGURE 6 Sociocultural semantics of technology.

5.2.1.2.4 Principle 9a: Co-determination I

Form of life, culture and domain of action are co-determined. The construct form of life is due to Pertti Saariluoma and Jaana Leikas (Saariluoma & Leikas, 2010), and it needs to be further unpacked in order to formalize the relations subsumed in the present assumption.

Inspired by Wittgenstein's usage of the term *lebensform* in relation to his analysis of language games (Wittgenstein, 1967), Saariluoma and Leikas (2010, p. 19) define form of life as "…any organized set of rules and regularities that people follow when they participate in this particular form of life" (cf. definition of culture as used in the present work in chapter 2).

The number and diversity of human forms of life as well as culture are limited only by the observer's ability to form taxonomies for them. Moreover the number and types of either construct, into which people participate, can vary at

the individual- and group-level of analysis, and are thus useful for etic and emic level analyses. Participation in a form of life is voluntary, involuntary or composite as one is enculturated or acculturates to a culture or multiple cultures during one's life cycle. The form and function of participation can vary during a life cycle. For instance one might have a form of life of a professional football player, born and enculturated into the dominant culture as well as the culture of athletes, situated within the borders of Finland. As a professional football player, one might have to acculturate to a culture of reduced physical abilities if one suffers a stroke, accidental injury or some other circumstances.

The preconditions for emergence of a given form of life are derived from biological, psychological and sociocultural factors (Leikas, 2009, p. 87). Consistent with principles 1, 4, 6 and 7a, evolution of a form of life could exert substantial changes to the various sectors of culture. For instance, continuing changes to the form of life of women, particularly in highly industrialized regions of the world, correlate to changes in work patterns and demography [infrastructural sector of culture], social institutions (e.g., family), domestic and national economy [structural], and changes to values, beliefs and attitudes [superstructural] (e.g. Cruiksbank, 2003; M. Harris, 1999, p. 26).

A form of life is composed of activities characterized by rule-following actions—that is, daily activities, routines and habits, as well as the facts and values of the form of life. These facts and values are interpretations of the biological, sociocultural and psychological bound phenomena, and they are employed to explicate behavioural and cognitive processes constitutive of a form of life. (Leikas, 2009).

5.2.1.2.5 Principle 9b: Context, content and cultural unit

Following principles 5 and 9a, the domain of action and cultural unit variables co-specify the context, content, and unit level of analysis for a form of life. The composites of various activities, facts, and values are called *domain(s) of action and experience*. These domains are the foremost interface between the observer (researcher) and the subject(s) of observation. Figure 7 illustrates the co-determining relation of form of life, culture, and domain of action and experience.

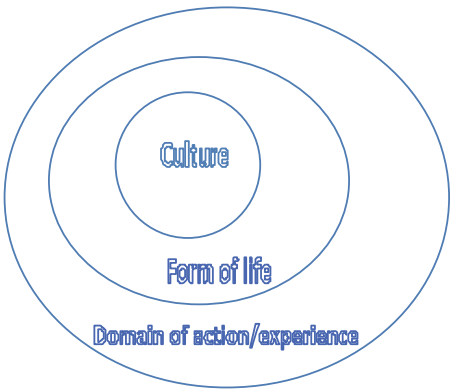

FIGURE 7 Relation of form of life, culture, and domain of action.

The culture construct is situated in the core of form of life because its tacit characteristic makes it difficult to foreground, and to emphasize the cultural boundness of forms of life. It follows that domains of action and experience are culturally bound. Culture is assigned a constitutive role because with some exceptions, it mediates many of the structural coupling interactions between humans and nature. Hence this placement serves as a reminder to the observer to go through the process of foregrounding, while looking for explanations to the human factors, which have direct implications to human-technology interaction, and therefore to systems design and engineering.

Domain of action and experience constitutes domains of human activity that provide content and context to human-technology interactions. Hence one "refracts" this domain through the prism of culture to view its culture-bound markers. These markers could be used to support development of hypotheses about the relations between goal types and interaction evaluation criteria, and to support analysis of their relations, hence enabling researchers to identify design relevant human-technology interaction attributes to conceptualizations of functions/features for new technology artefacts.

5.2.1.3 Facets of the analytical frame

5.2.1.3.1 Principle 10a: Influence of antecedents

Following principle 2, exogenous antecedents—that is, ecology, physical (geography, climate, natural resources), evolutionary trends, biopsychological factors, social processes and institutions—provide affordances and exert constraints on humans and on cultural processes (e.g., H. Harris, 1979; Schwartz, 1992). Influence of antecedents is the first facet of analysis.

5.2.1.3.2 Principle 10b: Stimuli processing

Following principle 10a, stimuli from antecedents (as well as consequents) move through basic cognitive processes—that is, perception, affect, and cognition (e.g., J.W. Berry et al., 2011; Cole, 1996; Heider, 1972; Markus & Kitayama, 2010, Matsumoto & Juang, 2008, Nisbett et al., 2001; Rosch, 1975). Since the antecedents are situated at the macro level, they can be employed to specify a typology for human cognitive and behavioural phenomena relevant to human-technology interaction research for a given domain of action. The typology is elaborated below. Processing stimuli with basic cognitive processes is the second facet of analysis.

5.2.1.3.3 Principle 11a: Motivational value orientation

On the individual level people employ values that help them choose cognitive and behavioural processes that in turn may assist them to realize a particular desirable end state or behaviour (e.g. G. H. Hofstede, 1980/2001; Schwartz, 2006). The desired existence is rooted in the human need to primarily fulfil biopsychological requirements (see chapter 5.3.1.1). Similarly, people learn to use values systems that promote the well-being of others on the group level in order to achieve particular group-level goals. Human-technology interaction pro-

cesses support achievement of desirable states or behaviours (that is, people's goals); therefore, since this desirable existence refers to a values system (e.g., G. H. Hofstede 1980/2001; Rokeach, 1973; Schwartz & Bilsky, 1990), which in turn is used to justify motivational goals, it follows that the processes support the achievement of values-based goals.

Since cultural values systems, which are manifestations of culture (e.g., Schwartz, 2013), refer to universal human problems grounded on biopsychological requirements, it follows that HTI should primarily support people's biopsychological requirements. It is also assumed secondary and subsequent requirements will need to be identified; however the focus of the present work is on primary requirements. Motivational goals and values orientation and their relations with cognitive and behavioural indicators comprise the third facet of analysis.

5.2.1.3.4 Principle 11b: Indicators of value orientation

A distinction between human-technology interaction as a process and as a component of technology interface usability was emphasized in chapter 3.1 in order to theoretically specify HTI's position and role in two contexts. The following theoretical assumptions are made regarding its role and position in the human-to-human and human-to-environment interaction contexts: the overall human-technology interaction process constitutes indicators or markers for cognitive and behavioural manifestations of universal human requirements; these requirements are (a) fulfilment of biopsychological needs grounded on the human biological structure (cf. M. Harris, 1979; C. Kluckhohn, 1951/1952), (b) social interaction needs (cf. F. R. Kluckhohn et al., 1961; Rokeach, 1973), and (c) societal-institutional interaction needs (cf. Schwartz, 2013). In other words, the mediation role of technology (that is, as an object between interacting humans, as well as between humans and their environments) makes use of concepts representing processes of human perception, cognition, emotion, values orientation, motivation, practices, rituals, and customs (i.e., the markers or indicators). These indicators constitute the fourth facet of analysis.

5.2.1.3.5 Principle 11c: Cognitive indicators of values

Values influence motivational goals. Their consequents include aspirations, beliefs and ideology (secular and religious), attitudes, norms, worldviews opinions, self-concepts, and moral reasoning (e.g., Markus & Kitayama, 1991; Rokeach, 1973, p. 13; Schwartz, 1999; Triandis, 1989; Vauclair et al., 2011).

5.2.1.3.6 Principle 11d Behavioural indicators

Behavioural indicators of value orientation include communication style (P. B. Smith, 2011), religious rituals (Dosanjh & Ghuman, 1996; Dosanjh & Ghuman, 1997); acculturation (J.W Berry et al, 2011), parenting (Dwairy et al, 2006; Chao, 1994; Chao, 2000), education (Chao, 2000; Chen & Stevenson, 1995, p. 1233), health practices (Matsumoto & Juang, 2008, p. 179), and abnormal behaviour (World Health Organization, 1979; Pote & Orrell, 2002; Okello & Ekland, 2006; Skounti, Philalithis, & Galanakis, 2007).

5.2.1.3.7 Principle 12: Interaction evaluation criteria

Following principle 10a through 11c, since people process stimuli through basic cognitive processes and employ values to appraise cognitive and behavioural manifestations of universal human requirements, it follows that they employ frames of reference in appraising stimuli. It is suggested that biopsychological needs, ethics and aesthetics are the primary frames of reference relevant to human-technology interaction (e.g., M. Harris, 1979, pp. 62-63; C. Kluckhohn, 1951/1952, p. 410; F. R. Kluckhohn et al., 1961, pp. 11-12; Rokeach, 1973, p. 8; Vauclair, Hanke, Fischer, & Fontaine, 2011, p. 187). Frames of reference compose the fifth facet of analysis.

5.2.1.3.8 Principle 13: Influence of ICT artefact usage

Specific to the information and communication technology field, it is assumed artefacts—for example mobile devices, mixed reality applications (i.e., augmented reality and virtual reality environments), and social networking systems such as Facebook—bring their own category of "digital culture" (Gere, 2002) wherein rules of interaction and interpersonal engagements rapidly change. These changes potentially affect psychological functioning and behaviour[25], which in turn could lead to changes in a socially learned ways of living (e.g., H. R. Markus & Kitayama, 2010).

5.2.1.3.9 Principle 14a: Co-determination II.

Consistent with principles 3 and 9a, since technology is a cultural phenomenon, and culture is a consequent of human life, it follows changes in technology supporting a given form of life could exert changes to a form of life and its related culture (see also presentation in chapter 3.2). Historians of technology have alluded to a co-determining inter-relation in this triad. For instance technological innovations that manifested in Germany and the United States during the late nineteenth and early twentieth centuries exerted substantial changes to the form of life of architects and artists in terms of knowledge and craft skills, and through their work, new technologies brought changes to many forms of life connected to the Western culture (Hughes, 2004, pp. 13-15).

In a similar although perhaps accelerated fashion, innovations of the late twentieth and early twenty-first centuries that have manifested in Europe and in the United States in the fields of telecommunication, computer science, nanotechnology, and biotechnology are exerting changes in the form of life of knowledge workers and related crafts men and women, and through their work changes in human life are cycling through the various regions of the world (Böhmer, Hecht, Schöning, Krüger, & Bauer, 2011; Cozzens & Wetmore, 2011; Ebert & Jones, 2009; Fitzgerald-Hayes & Reichsman, 2010; G. J. Hofstede et al., 2013).

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[25] See for example Nick Yee, and Jeremy N. Bailenson's work with the "Proteus effect" (Yee, & Bailenson, 2007)

5.2.1.3.10 Principle 14b: Technology is culture
Consistent with principles 1, 5, 7a, 7b and 9, and following principle 14a, introduction of an innovative adaptive technology into a form of life acts as a perturbation in the system (i.e. form of life). An innovative technology is either selected for or against dependent on its potential contribution to sustaining the health and well-being of people (principle 7b). Hence it is posited that adaptive technology selected for will exert changes in a form life, a process that consequently exerts perturbations and changes in the related level of culture, which subsequently triggers perturbations and latent need for new adaptive technology. This chain of events describes feedback loops and circular causality characteristic of open self-organizing systems (see e.g. Fuchs, 2008, p. 12.).

5.2.1.3.11 Principle 14c: Techno-cultural convergence
As stated in chapter 3.2, culture and technology are intertwined artefacts that play a role in the development of human life and experience. The circular co-determining relation and processes connecting the form of life-culture-technology triad synthesize potentials for positive contributions to sustaining human health and well-being on the individual and group levels.

5.3 Prism of culture

Drawing from the study of current human-technology interaction literature, and analysis of the dimensions of the problem space identified in chapter 1, the present work puts forward a theoretical model of cultural human-technology interaction (see Figure 8). Consistent with the principles described in the previous section, the present work submits that technology is a cultural artefact and phenomenon. The meanings of culture and technology are co-determined within the context of human interaction with the environment. Technology is subsumed in culture, and functions in the form of supporting artefacts used for

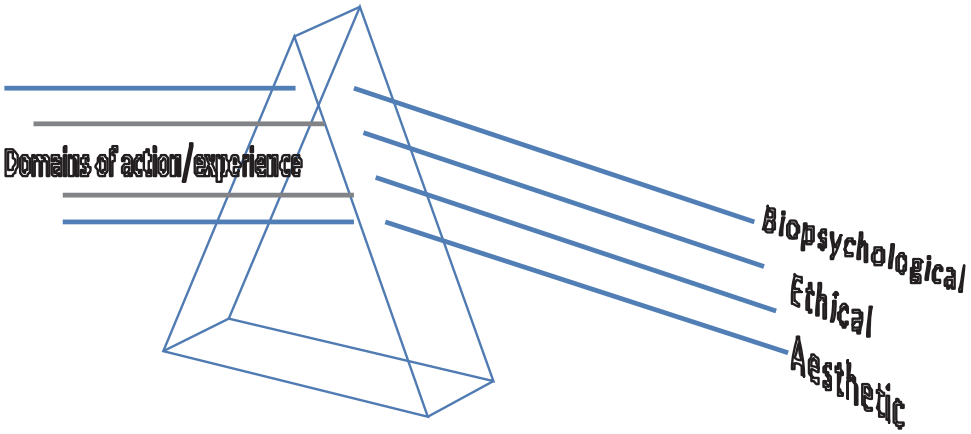

FIGURE 8 Prism of culture.

dealing with the constraints and affordances of the environment as well as of culture itself. The theoretical model posits that people consciously and unconsciously interpret the meaning and significance of technology within the context of domains of action by using values systems as criteria. The frames of reference for these values are human needs for biopsychological well-being, aesthetics, and ethics, and the desire for congruence between these needs. The model further posits that dissatisfaction with constraints can trigger a desire for a designed technology solution.

Alfred P. Weiss' raindrop analogy provides a useful supporting model for the convergence required in the field of human-technology interaction design research. In his analysis of purposive behaviour, Weiss described the convergence of diverse occurrences toward a common end stage in behaviour as like the way raindrops originally scattered over a wide area eventually move toward a common point, in the sea (Weiss 1925, pp. 346-47). If one accepts the thesis that technology is a cultural phenomenon, then culture can serve as the common point of convergence for the scattered analyses of human requirements for technology.

5.3.1 Theoretical model

The guiding principles previously articulated make explicit the circular structural coupling (in the autopoietic sense) of culture and technology. They are compatible with the assertion technology is a cultural phenomenon to the extent that the meaning of technology artefacts is socioculturally determined (Bloomfield & Vurdubakis, 1994; Feng, 2000; Winner, 1992); that is, people explicitly as well as tacitly employ culture-bound frames to interpret the meaning or meanings of technology artefacts as well as to reify the symbolic functions of technology. And with particular application to human-technology interaction design, it is suggested researchers could pay more attention to the ways people use the frames of biopsychological needs, ethics and aesthetics in evaluating phenomena. Moreover, the proposed theoretical model of cultural human-technology interaction design is compatible with the explicit and systematic application of the circular mutual determination in the causal relationship of phenomena manifesting at the infrastructure, structure and superstructure levels (in the cultural materialist sense) of human cultures.

Hence subsuming key features of the cultural materialist research strategy into a theory of cultural human-technology interaction provides a source of testable hypotheses as well as a source of parsimonious explications for observed techno-cultural phenomena. It also enables prediction as well as retrodiction of some events linked to human-technology interaction. This ontological co-determination is not only salient to understanding and explicating techno-cultural phenomena, it also the reason for using culture as the point of convergence in human-technology design research. Therefore, given the current divergence in research approaches to human-technology interaction, divergence that makes it difficult to make sense of the cumulative data up to this point, it is suggested that culture is the most viable construct from which one

can systematically describe and explain the differences and similarities in observed human-technology interaction.

While culture serves as a point of convergence, one can also use it like a prism through which human *domains of action and experience* are projected for further analysis. This process is akin to refracting a ray of sunlight through a prism in order to separate it into its constituent observable spectrum. One can similarly refract observable human actions and usage of technology through the prism of culture in order to examine their constituent components (Figure 8). Hence from the observer's (researcher's) point-of-view, one "sees" human actions and activities as they are refracted by culture.

5.3.1.1 Typology for cultural HTI markers

Consistent with principles 7a, 7b, and 12, the markers (i.e., indicators of human-to-human, and human-to-environment interaction processes) are organized under the rubrics *biopsychological*, *ethical,* and *aesthetic* (Figure 8). The proposed prism model is compatible with the Brunswikian lens model (Brunswik, 1955) in the sense that it assists in conceptualizing and unpacking a process detail (i.e., interpretation), which people employ to deal with the equivocality of environmental stimuli. Brunswik's model tells us the human lens is able to take divergent details of stimulus and converge it to a new focus, which in turn feeds back to the organism in a future state. The lens model, however, does not specify how perceived stimulus is evaluated as it goes through the process of convergence to a terminal focus. Hence it is proposed that the concept of culture as a prism could be used to unpack part of the process detail. This unpacking process allows the study of universal and culture-specific traits of the evaluation process, which is inferred to the convergence process.

5.3.1.1.1 Biopsychological, ethics and aesthetic rubrics

The term *biopsychological*, in the context of the present work, is used to acknowledge the inter-relation of biological and psychological preconditions to human life in general, and to forms of life in particular. This usage of the term, however, does not imply cultural antecedents to biological processes. For example, the theoretical framework proposed in the present work does not imply cultural influence on the biophysical processes of aging. The theory implies instead a role of culture as an intervening variable. The lens of culture is employed in interpretations (i.e., a cognitive process) of the social significance of aging in a given society. There are a variety of ways to describe universal human needs on the biopsychological level. A short list proposed by M. Harris (1979, p. 63) is adopted:

> "1. People need to eat and will generally opt for diets that offer more than fewer calories and proteins and other nutrients.
> 2. People cannot be totally inactive, but when confronted with a given task, they prefer to carry it out by expending less rather than more energy.
> 3. People are highly sexed and generally find reinforcing pleasure from sexual intercourse—more often from heterosexual intercourse.
> 4. People need love and affection in order to feel secure and happy, and other things being equal, they will act to increase the love and affection others give them."

The biopsychological rubric encompasses sets of sensory and cognitive processes known to vary across cultures; that is, variations have been observed regarding the patterns of interpretations derived from these processes. The ethics and aesthetics rubrics serve as categories for the patterns used in interpreting meanings of cognitive and behavioural sets. These patterns help one to see the interrelations between components observed within a domain of action. For instance cultural variation in visual perception is related to some construct of idealized congruence in the meaning of form and function; that is, a certain aesthetic value. Similarly, cultural variation in practices and customs is related to the ethical and aesthetic patterns governing interpretations of their meaning. In other words, while the biopsychological sets of processes are universal, cultural variations in the interpretations of their meanings can be mapped along the ethics/aesthetics axis. Ethics and aesthetics serve as a frame of reference.

Why aesthetics and ethics? A philosophical analysis of value systems and their role in human experience and action allows for a more nuanced view of these constructs as they are applied by the present work to human-technology interaction. Emily Brady argues that aesthetic values are embedded in people's relationship with nature, and people's attitudes toward the environment are grounded in aesthetics (Brady, 2006). This insight implies people unconsciously utilize aesthetics in evaluation of events, other people, and artefacts. Brady's insight is consistent with anthropological theory of culture (e.g. C. Kluckhohn, 1951/1952). Both anthropological (see presentation in chapter 5.3.1.2.1) and philosophical views of human experience and action identify ethics as a criterion for the prioritization process in value systems.

There is an inherent ambiguity in the relation between ethics and aesthetics—that is, in their role as criteria for value priorities— which should be foregrounded. One can argue for instance that several values delineated by Schwartz (1992) such as universalism, benevolence, tradition, hedonism, and tradition concurrently constitute ethical and aesthetic dimensions. Empirical work in the study of the relation between affect and values implies concurrent utilization of both constructs (e.g., Tsai, Miao, Seppala, Fung, & Yeung, 2007). On the one hand, one could theorize this ambiguity as due to specific characteristics of systems, or more precisely of self-organizing systems: complexity, nonlinearity, and inner conditionality (e.g., Fuchs, 2008, pp. 11-14). On the other hand, in the sense that they form a unity, aesthetics and ethics are one (Stengel, 2004, p. 612). Through their "style" (Stengel, 2004, p. 616) of self-expression in language, individuals reveal their evaluation of their form of life as lived ethically and aesthetically.

It is important to foreground the relation between ethics and aesthetics in the analysis of form of life, domain of action and relevant cultural level in view of known cultural variation in differentiating the two constructs. For instance in the case of Zen aesthetics and the context of Japanese national culture there is no delineation between the two constructs as they are applied to ritualized practices (Bai, 1997).

5.3.1.2 Rationale of rubrics

Biological and psychological differences between individuals in societies are reasons why variations are permitted and required (F. R. Kluckhohn et al., 1961). The present work submits that etic analysis of such individual biopsychological differences aggregated at the group, organizational, national, and supranational levels of culture could explain similarities and variations in the ways people think and feel about, and behave with technology.

The rationale for employing the rubrics biopsychological, aesthetics and ethics is derived from the analysis of empirical studies reviewed. It has been noted that a majority of empirical studies in the field of human-technology interaction with regard to cultural factors concentrate on usability issues. The studies limit their examination to the relationships between culture and perception, cognition, emotion, ethics, and aesthetics. This trend implies the importance assigned to the basic human modalities in thinking, feeling and acting. Cognitive style is related to ecological variables (Nisbett, 2003/2004); hence people can be expected to unconsciously utilize biopsychological factors as criteria in style definitions. Communication style is evaluated through ethical and aesthetic standards (Hall, 1959/1973; Hall, 1976). Emotion appraisal could be grounded on an aesthetic ideal (Tsai et al., 2007). Technology and design researchers have emphasized the salience of examining the ethical and aesthetic dimensions of contemporary technologies particularly in the context of the mediating role of societal processes (Findeli, 1994; Tripathi, 2010). Reviews of the literature have noted a predominant usage of value dimensions in various approaches examining the relationship between cultural factors and technological interfaces. Hence the biopsychological, ethics and aesthetics rubrics should provide human-technology interaction researchers empirically and theoretically supported categories for an analytical framework.

Notwithstanding the criticism of over-reliance on Hofstede's value dimensions of cultural variability (reviewed in chapter 2), the use of values in human-technology interaction research strategies remains a viable practical option. Since Hofstede (1980/2001) provided index scores for over 50 national cultures, his dimensions can be used to make predictions about cultural variability (Gudykunst, Ting-Toomey, & Chua, 1988, p. 50). Assuming that a theoretical connection between one or several of the dimensions and preference for some trait of technology, it is possible to make predictions about which culture would have highest, lowest or middle scores for a particular technological trait, for example, adoption of e-government services (Arslan, 2009; Lean, 2009).

5.3.1.2.1 Values as metadata

But what are values? "Values are socially shared conceptions of what is good, right, and desirable. They operate at multiple levels" (Knafo et al., 2011, p. 178). Values affect the way people perceive and interpret their environment; they influence preferences, choices, and actions (Knafo et al., 2011, p. 178). On the

national cultural level, values are explicitly and implicitly shared[26] notions of ethical and desirable existence and behaviour in a society (Williams, 1970). National cultural level values manifest as a response to basic existential problems that all societies must deal with (G. H. Hofstede, 1980/2001; F. R. Kluckhohn et al., 1961; Schwartz, 1999). Hofstede (1980/2001, p. 5) defines values as "a broad tendency to prefer certain states of affairs over others". F. R. Kluckhohn et al. (1961, p. 4) define value orientations as "complex but definitely patterned (rank-ordered) principles, resulting from the transactional interplay of three analytically distinguishable elements of the evaluative process—the cognitive, the affective, and the directive elements—*which give order and direction* to the ever-flowing stream of human acts and thoughts as these relate to the solutions of '*common human' problems*" [emphasis added]. Shalom H. Schwartz follows Rokeach (1973)[27], and C. Kluckhohn (1951/1952)[28] in adopting a view of values "as the criteria people use to select and justify actions and to evaluate people (including the self) and events… rather than as qualities inherent in objects" (Schwartz, 1992, p. 1). Thus while previous reviews (i.e., Clemmensen & Roese, 2010; Kappos & Rivard, 2008) observed an over-reliance on using value dimensions, it is suggested that there is another way to interpret the popularity of using Hofstede's dimensions: as an implicit acknowledgment of the construct's importance in modeling the process of interpreting the meaning and significance of phenomena.

If values are used to interpret the meaning and significance of phenomena (i.e., common human problems, people, events), it follows they are also used to interpret the meaning and significance of technology or desires for a technological solution. Drawing from the study of the human-technology interaction literature reviews and consistent with principle 7b and 11b, it is hereby proposed that the frame of reference of values and values systems is the drive toward biopsychological well-being, and needs for aesthetic and ethical congruence with this drive. Hence the usefulness of values lies in their role as metadata for these human drives.

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26 Fischer and Schwartz (2011) have recently challenged the notion of sharedness in the context of national culture.

27 "To say that a person 'has value' is to say that he has an enduring belief that a specific mode of conduct or end-state of existence is personally and socially preferable to alternative modes of conduct or end-states of existence" (Rokeach, 1973, pp. 159-160).

28 "There is a philosophy behind the way of life of each individual and of every relatively homogeneous group at any given point in their histories. This gives, with varying degrees of explicitness or implicitness, some sense of coherence or unity both in cognitive and affective dimensions. Each personality gives to this philosophy an idiosyncratic coloring and creative individuals will markedly reshape it. However, the basic outlines of the fundamental values, existential propositions, and basic abstractions have only exceptionally been created out of the stuff of unique biological heredity and peculiar life experience. The underlying principles arise out of, or are limited by, the givens of biological human nature and the universalities of social interaction. The specific formulation is ordinarily a cultural product. In the immediate sense, it is from the life-ways which constitute the designs for living of their community or tribe or region or socio-economic class or nation or civilization that most individuals derive their mental-feeling outlook" (C. Kluckhohn, 1951/1952, pp. 409-410).

This notion of biopsychological, ethical and aesthetic needs as meta-criteria is consistent with previous theoretical works (G. H. Hofstede, 1980/2001; G. H. Hofstede et al., 2010; F. R. Kluckhohn et al., 1961; Rokeach, 1973; Schwartz, 1992; Schwartz, 1999), although it has not been articulated as it is in the work at hand. F.R. Kluckhohn et al.'s (1961) definition implies the existence of a frame of reference for values, and postulates "innate goodness or badness of human nature as one of the antecedents of variation in value orientations (F.R. Kluckhohn et al., 1961, p. 11-12). Rokeach (1973, p. 12) describes three traits of values and value systems as standards guiding human actions, as a strategy for conflict resolution and for decision-making, and as expression of human needs. He specifies a value system as "a learned organization of principles and rules…" (Rokeach, 1973, p. 14), and suggests that as a motivational function, values could be ordered in a continuum suggested by Maslow's (1954 as cited by Rokeach, 1973, p. 16) theory of motivations. Levitin (1973, p. 494 as cited by Hofstede, 1980/2001, p. 7) classified values in terms of aesthetics and ethics. G. H. Hofstede (1980/2001, p.6) defines values as "feelings with arrows to them: Each has a plus and minus pole". His list of concepts (G. H. Hofstede, 1980/2001, p. 6; G. H. Hofstede et al., 2010, p. 9) that values deal with constitute the following:

(a) Dangerous versus safe
(b) Abnormal versus normal
(c) Evil versus good
(d) Moral versus immoral
(e) Dirty versus clean
(f) Ugly versus beautiful
(g) Decent versus indecent
(h) Paradoxical versus logical
(i) Irrational versus rational

Schwartz (1992) defines values as criteria for evaluation of events and people, and for selecting and justifying actions, differentiates values according to motivational goals underlying them, but he does not provide explicit theoretical support for how and why people prioritize conflicting as well as congruent values.

It is important to note that the rubrics aesthetics and ethics serve as frames of reference for values as well as frames for cultural traits organized under the biopsychological rubric. This differentiation comes into play at the stage of analysis and collection of design relevant attributes from the studies of form of life and related domain of action.

Consistent with principle 9a as well as the Schwartz cultural value orientation theory (Schwartz 1999; Schwartz, 2006), it is proposed that sociocultural affordances on a domain of action trigger harmony values due to relative satisfaction with outcomes of activities in the domain. In contrast, sociocultural constraints trigger mastery values due to relative dissatisfaction with the outcomes. It is therefore proposed that sociocultural constraints could trigger desires for

designed technology solutions. Conversely, sociocultural affordances could trigger resistance to or rejection of technology solutions.

5.3.1.3 Weighting of value antecedents

The theoretical model at hand submits that elucidating the importance of the influence of biopsychological, ethical, and aesthetics needs in choosing a given value from a field of alternatives would provide another level of granularity (i.e. cultural responsiveness) to descriptions of causal relations between espoused values in the context of form of life and related domain of action. This level of granularity should allow one to hierarchically organize phenomena observed within a form of life and domain of action, to conceptualize and organize design-relevant attributes aligned with the relative weighting of related components and underlying values. Weighting of value antecedents in the context of studying forms of life and related domains of action would be one way to deal with the inherent complexity of value systems. Complexity of systems in this context is defined as the "number of conflicting constraints" (Kauffman, 1993, p. 47) in a system.

5.3.1.4 Propositions

Based on the preceding description of the prism of culture model, the following propositions are submitted.

Proposition 1: The greater the magnitude of constraint on pursuit of a given value, the greater the immediate dissatisfaction with the constraint.

Proposition 2: The greater the immediate dissatisfaction with a constraint, the greater the openness to change, and vice versa.

Proposition 3: A decrease in the benefits from a production-related[29] activity would produce an increase in the latent need for alternative ways of accomplishing the activity.

Proposition 4: An increase in the search for alternative ways to accomplish a constrained activity will produce an increase in the openness to change.

Proposition 5: An increase in the openness to change will produce an increase in desire for an immediate solution.

Proposition 6: An increase in the number of constraints on a production activity will produce an increase in desire for technology support.

Proposition 7: the greater the subjectively perceived constraint, the greater is the latent need for a designed solution to modify or overcome the perceived constraint on behaviour.

Proposition 8: An increase in biopsychological related constraints will produce an increase in the latent need for technology solutions.

Proposition 9: An increase in sociocultural related constraints will produce an increase in the latent need for technology solutions.

Proposition 10: An increase in the relative weight of biopsychological related needs specifying a given value will produce a decrease in the relative weight of ethics in the specification of the same given value, and vice versa.

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[29] That is in the context of the infrastructure sector of culture. See also principles 7a-7c.

Proposition 11: An increase in the relative weight of biopsychological related needs specifying a given value will produce a decrease in the relative weight of aesthetics in the specification of the same given value, and vice versa.

Proposition 12: An increase in the relative weight of ethics needs specifying a given value will produce a decrease in the relative weight of aesthetics needs specifying the same given value.

5.3.2 Limitations

The primary application of a culturally responsive human-technology interaction research is to make explicit cultural factors relevant to systems design; that is, to describe and explicate the questions that need to be asked in order to gather data, which serve as input to describing the human requirements for a specific systems design and engineering project. These human requirements eventually must be translated into systems requirements from which designers can base their work (Chapanis, 1996). This means the human-technology interaction research professional must identify and describe *what* design-relevant factors are affected by culture, and quantify *how well* the designed solution must meet the human requirements linked to these factors. *How* the solution is designed remains in the domain of the designer. The basic research contained in the present work addresses only the issues of what design relevant factors are culturally bound and why they are bound. The work of figuring out how well a design solution must meet the requirements, however, remains in the realm of specific systems engineering projects. The processes of research and design are two inter-related but nevertheless discrete processes.

5.4 Summary

The present chapter argues for utilizing culture, in its inter-connected roles as construct, structure and practice (Bauman, 1973), as a point of convergence for examining the similarities and differences in people's interaction with technology. This chapter elaborates a theoretical understanding of the complexity of sociocultural systems and the relations between the sectors and components of such a system as they manifest in people's interaction with technology. Theory development has been grounded on theories from cultural materialism, general systems theory, embodied cognition theory, and cultural psychology. The proposed theoretical model aims to fill part of the gap in theory development as identified by precedent observers. The prism of culture model aims to aid empirical work supporting early-stage conceptualization of innovative technology. The theoretical model is envisioned for application in the field of human-technology interaction design.

The rationale underlying the arguments for utilizing culture as a convergence point for human-technology interaction design research is founded on the principle that culture is an appropriate construct for deconstructing ob-

served human phenomena at the group level of analysis, namely at the level of a form of life and related domain of action. Culture as a construct in this context allows for a systematic deconstruction of a given form of life/domain of action dyad with the aim of drawing out both culture-connected similarities and differences in the processes of appraisal and interpretation of events governing human interactions. The results of empirical work grounded on the proposed theoretical model should also enable the foregrounding of potential ethnocentric bias embedded in the research and conceptualization processes with regard to constructs and assumptions about cultural variables of interest both in the context of the source and target cultures.

The contributions of the present theoretical model to current theory development for a culturally responsive human-technology interaction design are two-fold: (1) the proposition focusing on the influence of constraints on people's latent need for a designed technology solution. This proposition has been further deconstructed into twelve sub-propositions elaborated in the preceding section; and (2) the proposition to utilize the weighting of the influence of biopsychological, ethical, and aesthetic needs on the choice of the predominant value among the value set used in the appraisal and interpretation processes (i.e. propositions 9 through 11 in chapter 5.3.1.4). It is the present work's contention that knowledge of the weighting of value antecedents would provide a more nuanced view of people's values prioritization (Schwartz, 1992; Schwartz, 1999). This view is important particularly for the early stage of conceptualizing innovative adaptive technology that is aligned with the relevant level of culture of the target users, because not only would it allow the use of empirically supported concepts and human factors requirements to subsequent design and engineering processes, it would also allow prioritization of design relevant attributes, which have effects on the whole life-cycle of technology artefacts.

The rubrics biopsychological, aesthetics, and ethics serve to simplify, and to make manageable, the organization and analysis of human requirements. There are many inter-relations between components that are still not well understood, and one cannot overemphasize the limitations of the rubrics presented here for describing such complexity. Thousands of books and scientific articles have been written about human psychology, physiology and anatomy as well as anthropology and sociology, and not a single book, not to mention a single chapter in a monograph, can adequately present all the material. Hence the present work concentrates on factors that have direct relevance to the design process.

6 IDENTIFYING DESIGN RELEVANT ATTRIBUTES

In reviewing journal articles of the past 10 years, one can see a pattern with regard to design relevant attributes deemed salient to the form/function of technology artefacts. Six attributes have been identified: perception, language, emotion, cognition, aesthetics, and ethics. These attributes have been examined in the majority of the empirical studies particularly those concerned with usability as the key component to aligning products with people's needs. The study of culture's relationship to human-technology interaction to a great extent compels the researcher to cross the borders between disciplines. From the perspective of studying culture, design, and human-technology interaction, the field of cognitive science provides a portal to an interdisciplinary approach. It also provides the boundaries within which the six attributes are situated. Cognitive science's reference disciplines provide theories that inform approaches and research methodology. This chapter presents the issues and theories concerning perception, language, emotion, cognition, aesthetics, and ethics as viewed with the lens of cognitive science. The chapter further elaborates principles introduced in preceding chapters and particularly in chapter 5 to support the formation of questions that must be addressed to draw out design-relevant attributes from the study of a given form of life/domain of action.

Several decades of cross-cultural research in human psychological processes have contributed to the understanding of the variability and universality of being human. Cross-cultural research has uncovered psychological processes that appear to be universal: the perception of language and colour, processes of language acquisition, principles of cognition and learning, gender differences in mate selection and gender stereotypes, and recognition and expression of facial expressions. These findings provide important bases by which one could find similarities with fellow humans. Cross-cultural research has also found important cultural differences in the phenomena of cognitive, moral, and socio-emotional development, psychopathology and physical health. The biggest challenge in cross-cultural psychology is not in the compilation of cultural differences in the various psychological facets. It is rather in the development of

theoretical models and conceptual frameworks that explain how cultures are both similar and different, and why. (Matsumoto, 2001).

The foregoing examples are part of a non-exhaustive list. Many phenomena involving human cognition, emotions, and experience still await both proscriptive theories as well as empirical examination. The more salient point to remember however is that much of the findings from cross-cultural psychology studies thus far have had positive impact on designing interventions to aid in promoting people's well-being, as well as in enabling better understanding of enduring questions regarding language, perception, thinking, emotions, and moral behaviour, all of which are arguably *cultural items* and thus their effects on everyday life are *cultural effects*. Findings from cross-cultural research are indispensable in the design of human-technology interaction. It is important, however, to also acknowledge that their implications are subject to ongoing contention.

6.1 Rationale for studying attributes

The attributes listed under the biopsychological rubric are ones most often mentioned in the literature. They are considered most relevant to conceptualization and design of user interfaces. Studying cultural variability in the ritual and practices relevant to a given domain of action is most relevant to supporting the conceptualization process—that is, envisioning extensions to or innovating new forms of life and domains of action as well as envisioning a new technology or new combinations of existing technology. Hence they are also most relevant to envisioning functions and features for a given technology.

6.1.1 Culture, language, perception, and cognition

If culture has a causal relationship with human experience, how does it then influence human cognition, emotion, and action? The significance of language as a cultural trait has been briefly mentioned. In this context, the term *trait* is employed in the biological sense to emphasize language partly as a genetically determined characteristic of the human species, and partly as a culturally determined characteristic. The human capacity to communicate using a semantic symbol language involves a genetically determined predisposition to acquire such a language, and no other known animal species share this predisposition. Researchers have presented empirical evidence suggesting that language affects human perception and thoughts to the extent that different modes of thinking are distinguishable among different groups (Roberson, Davies, & Davidoff, 2000; Roberson, Davidoff, Davies, & Shapiro, 2005). Others claim that these differences are modest and do not necessarily support the notion of radically incommensurable worldviews (Berlin & Kay, 1969; Heider, 1972; Rosch, 1975). And still others argue that these traditional opposing views break down from

the perspective of recent empirical findings (Boroditsky, 2001; Kay & Regier, 2006).

The study of colour perception provides an example of a paradigmatic domain where scientific study of culture and human experience intersect. The study of the relationships between colour, culture, language, emotion, and cognition is also a disputed domain. Consider for example the linguistic aspects of colour. There are many names in English for colours: red, green yellow, blue violet, pink, turquoise and so forth. These many names in English as well as numerous names in other languages imply that colour categories are arbitrary. At one time the hypothesis of linguistic relativity, also referred to as the Sapir-Whorf hypothesis (see Kay & Kempton, 1984 for a review), had been the dominant view in the fields of linguistics and anthropology (see e.g., Matsumoto & Juang, 2008, pp. 231-235; Varela et al, 1991/1993, p. 168). This hypothesis holds that each language codes experience into sound in a unique way. Thus every language is semantically arbitrary in relation to other languages. This view was challenged when Brent Berlin and Paul Kay published their now classic work.

In an examination of over 90 languages, Berlin and Kay (1969) found that there are at most 11 basic colour categories encoded in any language; however, not all languages encode all of them. These categories are white, black, red, green, blue, yellow, pink, brown, purple, orange and grey. The authors found considerable variation among speakers of various languages regarding the boundaries of colour categories, but informants always agreed on the best example of a colour category. Moreover, they found that when several languages have a common basic term, for example a basic term for blue, the informants always agreed on the best example of that colour category regardless of the language they spoke. Berlin and Kay (1969, pp. 4-5) hence argued, "…the referents for the basic colour terms of all languages appear to be drawn from a set of universal perceptual categories, and these categories become encoded in the history of a given language in a partially fixed order. There appears to be no evidence to indicate that differences in complexity of basic colour lexicons between one language and another reflect perceptual differences between the speakers of those languages".

Subsequent studies published by Eleanor Rosch (previously Heider, e.g. Heider, 1972) found that while some languages do not encode all 11 basic colour categories, a given language always encompasses the entire basic colour space. Rosch's work with the Dani tribe of New Guinea showed that while the Dani language has only two basic colour terms, white and black, the former term constituted white plus the colours red, yellow, reddish-purple, pink, and orange, whereas the latter term covered black plus the colours blue and green. However, Roberson et al.'s (2000) failure to replicate Rosch's results with the Dani tribe continued the contention regarding pan-human universality of colour categories. These on-going debates about linguistic effects on perception and thinking might seem too academic to warrant the attention of laypersons, until one realizes that theories regarding these effects are being applied, for example, to the design of education programs and technology supported inter-

ventions in learning environments. It makes a difference whether an intervention program, inclusive of linguistic aspects, is based on a universal view or cultural relative view of perception and cognition (Cassell et al., 2009; C. D. Lee, 2003).

6.1.1.1 Ecological model and perception

Language is not the only cultural trait that influences human cognition, action, and experience. Other researchers have argued that methods of subsistence, and habitat mediate cognition. From this perspective, one can see culture's status as an interface between the environment and the human organism. John W. Berry's (Berry, 1971) early comparative work demonstrated that ecological demands on a group of people in addition to their cultural adaptation to these demands mediate visual spatial skill development. Specifically, he argued that people who live in ecosystems where hunting is the mode of subsistence possess good visual discrimination and spatial skills that have been adapted to the ecological demands of hunting. Furthermore, cultural aids such as language coding, arts and crafts, and socialization are adapted to the ecological demands, and help in the development of the necessary skills. Studies of pictorial perception in the context of socioeconomic dimensions provide insights to perceptual variations in for example perception of symbols (Mishra, 1982).

With regards to language aids, Berry (1971) argued that the presence of geometrical spatial terms help transmission of spatial and orienting concepts. The presence of these terms in the language of hunter-gatherer societies is consistent with the spatial demands put on them by their ecosystem. With respect to arts and crafts, it has been argued that using them help in early learning of spatial manipulations and the discrimination of detail. Berry (1971) subsumes arts and crafts under the rubric "technology". The development of technology is also consistent with the demands of an ecosystem. Socialization practices in hunter-gatherer societies have been found to emphasize independence and self-reliance. Implicit in Berry's hypothesis is the prediction that visual discrimination and spatial skills, as well as the three cultural aids (linguistic aspects, arts and crafts, and socialization) will diminish as hunting diminishes in importance.

6.1.1.2 Ecological model and cognitive style

Other scholars extend the notion of nature and culture's circular coupling interaction by integrating the influences of material conditions into theories useful to the study of culture and human cognition. Nisbett, Peng, Choi, and Norenzayan (2001) posit that influences of material conditions on philosophies and worldviews that remain dominant respectively in Western and Eastern cultures manifest in the cognitive style of individuals from these cultures. Differences in philosophical traditions between Western and Eastern cultures have been suggested as a causal account for the social differences among different cultures, and manifest as differences in the socio-cognitive systems of cultures. The authors present a large body of work as backing for six propositions:

> "(1) Social organization directs attention to some aspects of the field at the expense of others. (2) What is attended to influences metaphysics, that is, beliefs about the na-

> ture of the world and about causality. (3) Metaphysics guides tacit epistemology, that is, beliefs about what it is important to know and how knowledge can be obtained. (4) Epistemology dictates the development and application of some cognitive process at the expense of others. (5) Social organizations and social practices can directly affect the plausibility of metaphysical assumptions, such as whether causality should be regarded as residing in the field versus the object. (6) Social organization and social practices can influence directly the development and use of cognitive processes such as dialectical versus logical ones" (Nisbett et al., 2001, pp. 291-292).

The authors use a historical comparison of the development of Greek and Chinese cultures to generalize their argument that differences in the ecosystems, in which Greek and Chinese cultures developed, provide a causal account for the differences in the socio-cognitive systems in these cultures, particularly the differences in their notions of metaphysics and epistemology. These differences manifest in the respective culture's social organization and social practices, which subsequently influence the cognitive processes of individuals enculturated into these sociocultural systems. Furthermore, Nisbett et al. (2001) maintain that these differences are present in contemporary Western (i.e. European and post-Colombian) and Eastern (i.e. East Asian, including Japanese and Korean, and Southeast Asian) cultures, which trace their philosophical lineage to either the Greek (i.e. Platonic) or Chinese (i.e. Confucian) philosophical traditions.

The authors' explanation for cognitive differences gives primacy to the material conditions found in the Greek and Chinese ecosystems. Chinese civilization was based on agriculture, which required substantial cooperation among individuals to carry out subsistence production activities as well as economic activities. These infrastructural and structural practices led to the organization of a hierarchical state whose emperor and bureaucracy controlled the lives of individual Chinese. It has been suggested that harmony and social order became core values in the Chinese context, and the resulting social orientation is characterized as "collectivist" or "interdependent", as distinguished from "individualistic" or "independent" social orientation, which is characteristic of societies, like the Greek society, whose subsistence production depended on hunting, fishing and trading.

The Greek ecosystem is not very conducive to development of an agrarian base; it consists of mountainous terrain descending to the sea. This type of ecosystem is more suitable to herding and fishing than to large-scale agriculture. It has been speculated that the sense of personal agency characterizing the Greek people could have been a natural response to the material conditions and the resulting decentralized polity of their region. In contrast to the centralized Chinese polity that had absolute control over individual lives, the politically decentralized Greek city-states provided a greater scope for independent action. Ancient Greece enabled greater scope for mobility relative to ancient China. Citizens of Greek city-states moved freely from one city-state to another. Easy access to the sea (relative to the Chinese conditions) provided an escape route for dissidents. Moreover, Greek traders operated at the ancient world's major crossroads, giving them access to a variety of interactions that were not available to their Chinese counterparts.

The nature of Greek social orientation meant that debate posed little interpersonal risks, thus debate became integrated into the political systems of Athens and other city-states. It has been suggested that the developmental characteristics of the Greek city-states eventually manifested in the developmental timeline of other European states, particularly the reduction of reliance on agriculture and the rise of independent city-states with economies based on crafts and trade, which eventually gave rise to the modern market economy. The European developmental trajectory included the repetition of the Greek social forms and intellectual traditions, which included the rediscovery of science. Technological changes such as the invention of the printing press enhanced the scope for freedom and mobility of ideas. The Chinese invented movable type before the Europeans, but it was suppressed on the grounds that the authority of the government would be undermined[30].

Nisbett et al. (2001) further extended the causal reach of material conditions to cognitive styles by linking the social products of the ecological-metaphysical-epistemological causal chain to the notion of a causal relationship between the relative strength of social networks and a holistic, or *field dependent* orientation to the world, as distinguished from an analytical, or field independent orientation. The term field-dependent is due to Witkin (Witkin, 1950; Witkin, 1967) who made a distinction between field-dependent and field-independent modes of perception. A field-dependent individual tends to notice context and the relationships between objects. The organization of the whole field dominates perception of its parts. Field-independent people, in contrast, perceive items as discrete from the organized field.

Nisbett et al.'s (2001) work in addition to seminal contributions by Richard A. Shweder (e.g., Shweder & Sullivan, 1993), Michael Cole (Cole, 1996), Hazel R. Markus and Shinobu Kitayama (Markus & Kitayama, 1998; Markus & Kitayama, 2010), and Alan P. Fiske (Fiske, 2002) contribute a body of literature analysing issues dealing with the relationship of culture and cognition, and has been instrumental in the formation of the cultural psychology movement, as distinguished from cross-cultural psychology. The points of contention revolve around three main themes: the magnitude of cultural effects on cognition, the universality of cognitive process, and the fixedness of cognitive process. Nisbett et al. (2001) for instance claim cognitive differences that they have found are not merely large but that are also qualitatively significant. That is, in study after study, East Asians and Americans responded in qualitatively different ways to the same stimulus situation. These qualitative differences imply that in dealing with the same problem, East Asians and Westerners often invoke different cognitive processes.

The issue of universality of the cognitive process has already been touched on in the discussion of language and colour perception. Proponents of the cultural psychology, or relativistic, view argue that an indefinitely large number of

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30 See also analysis of the question why the Europeans navigated to the new world instead of the Chinese even though China was more technological advance in W.I. Thompson, 2007, p. 111).

presumed basic (i.e. universal) cognitive processes are highly malleable to the effects of culture. The issue of fixedness of cognitive content is closely linked to the issue of universality. On the one hand, it has been argued that cognitive content is learned and indefinitely malleable. On the other, investigators present evidence that some cognitive content might not be susceptible to cultural influence. For example, naive theories of mechanics and physics, naive theories of biology, and naive theory of mind appear early in human development and are so widespread that it is plausible that some of their aspects are largely innate, and resistant to sociocultural modification. Theories of causality are part of an organism's cognitive structure. In Nisbett et al.'s (2001) view, however, presuppositions stating cognitive content is learned and malleable, and presuppositions asserting cognitive processes as universally the same and biologically determined are both wrong. They suggest a middle ground view that some important content might be universal and innate, and some important cognitive processes might be highly alterable.

The foregoing discussion juxtaposes ongoing concerns about culture and the human experience that has ramifications for human-technology interaction. As Nisbett et al. (2001) observe, disputes involving polarized views of human cognition are not as useful as moving toward a middle path to produce viable theories that can be empirically investigated. The import of ongoing doubts about the causal relationships between culture and cognition is in questioning the foundations of the generally accepted view.

The construct of innate mental logic has aided in paving the way for the emergence of modern computing and eventually the development of the computational theory of mind[31]. However, if there is no innate mental logic and if cognition is susceptible to sociocultural modifications, then the received view of the computational theory of mind might also need modifications. Another point to consider is that while cultural differences might not refute computational approaches, the continuing doubts stated above should serve as a reminder that one cannot assume by default that the human mind functions like a classical computer, as distinguished from a computer modeled on connectionist theories or some other theory such as enactive cognition[32].

Variation in perception leads to questions about the received view on the modularity of the mind. Research on field dependency (e.g. Künen, Hannover, & Schubert 2000 cited by Nisbett et al., 2001) presents evidence that social orientation such as collectivism can be primed. Linking this to Nisbett et al.'s (2001) findings, it follows that perceptual processing style could be altered rather quickly through priming. Consequently, processes such as perceptual learning might be more susceptible to top-down processes, that is, learning that goes from explicit to implicit knowledge, as distinguished from bottom-up processes, that is, learning that goes from implicit to explicit knowledge[33], than the way it has been acknowledged.

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31 See e.g. Bonatti, 1994
32 See e.g. Brooks, 1989; Brooks, 1991.
33 See e.g. Sun & Zhang, 2004.

The preceding examples have practical impacts on the design of human-technology interaction. The work of Rodney Brooks is exemplary in going beyond the received view in artificial intelligence to operationalize the notion of intelligence without representation in robotics. In addition, contemporary work in applying correlation learning to the field of computer science indicates acknowledgement of the plasticity of human cognitive processes. While Brook's work focuses on cognitive processes, other investigators (e.g., Nazir et al., 2009) have recently began to incorporate into their work theories and empirical evidence from studies of human emotion.

6.1.2 Culture, language, and emotion

Emotion is a fundamental feature of human experience, and it is considered a pan-human trait (Ekman et al., 1987; Matsumoto et al., 2007). One could infer from the literature on the language of colour that culture and emotion have a causal relationship, if one accepts the idea that emotion is intertwined with cognition. How is culture connected with emotions and subsequent behaviour? What are the implications, for instance, of variations in lexical *re-presentation* of the feeling of love? Physical expressions of affection and reactions to such expressions vary from culture to culture. In Paris, during a walk along the river Seine on any given day, one notices how people kiss passionately in public while everybody walks by nonchalantly; whereas similar expressions of affection in Delhi could land a married couple in court because they are breaking the law against obscene public behaviour (Dey, 2009). In Dubai a passionate kiss in public might entail going directly to jail without recourse to a court of law (Malm, 2013). Hence, sociocultural conventions can determine what arouses people's emotions as well as how they express emotions.

Emotions are universal. Or are they? This deceptively simple question is loaded with controversy. Subject to debate are issues ranging from emotions' substance, to their distribution, to their logical form. Issues regarding substance surround the question of whether emotions are reducible to feelings, bodily sensations or psychological facts. Michelle Rosaldo (1984, as cited in Wierzbicka 1999, p.2) describes emotions as "…thoughts somehow 'felt' in flushes, pulses, 'movements' of our livers, minds, hearts, stomachs, skin. They are *embodied* [emphasis in the original] thoughts…." With regards to the issue of substance, some scholars assert that emotion is universal and indeed it is a trait that is found in all mammals. While its universality is widely accepted, cross-cultural research has found that the way humans show emotion and appraise their expression vary from one culture to another (Ekman et al., 1987) Other scholars, however, maintain that there are no universal emotion concepts; that is, claims for universality of psychological state terms are doubtful, because the terms do not easily map lexically across all human languages (Shweder, 1994; Wierzbicka, 1999)

Anna Wierzbicka argues that the concept of "emotion", in the English language, is culture-bound and cannot be safely used in investigations of human

experience and human nature, whereas the concept of "feeling" is universal (Wierzbicka, 1999, p. 4) and therefore better suited for the investigative enterprise. According to Wierzbicka, the semantic ambiguity of the English word emotion is due to the subsumption into the term of the combined references to the concepts of feeling, thinking and embodiment. She further argues that one can talk about a feeling of hunger or feeling of loneliness, but not an emotion of hunger nor loneliness, because while these feelings are related to thoughts of hunger or thoughts of isolation, they do not "suggest any associated bodily events or processes (such as a rising blood pressure, rush of blood to the head, tears, and so on)" (Wierzbicka, 1999, p. 2).

Shweder (1994) points out that unlike natural objects such as plants and animals, "which exist in the world as perceptible kinds that one can directly point at and inspect, the 'emotions'… are transcendent 'narratives' or 'scripts' and the biological chemical states, expressive signals, phenomenological reports, action tendencies, and judgments that we associate with 'emotions' as symptoms or indexes are not unified in the same way as are such clusters as natural object attributes…. "(Shweder, 1994, pp. 34-35).

The synchronicity of emotion and perception is also controversial. The received view of the relationship between emotion and perception, according to Francisco Varela, is one in which emotion somehow colours perception, therefore suggesting that perception comes first, with emotion layered on top. Varela suggests another point of view, that emotion is closely coupled with the predisposition to motion. It is not that one has a perception that one paints with an emotion. Instead, perception is already intrinsically emotionally shaped as one interacts with the world. Indeed, there could not be a perception without an emotional component[34]. Varela (2000/2003, p. 323) says, "I would distinguish as a distortion a very deluded perception when that emotion becomes, for example, so very prolonged that it is dysfunctional or pathological. But even in normalcy there is no such thing as perception without emotion."

One can easily get sucked in to the whirlpool of controversy in any science involving criss-crossing of disciplinary boundaries. Findings from ethnographic research and cross-cultural psychology-specific research regarding cultural differences and similarities in emotional experience, for example, consistently diverge. Jeanne L. Tsai and her colleagues attempt to offer a way out of this conundrum by proposing an affect valuation theory (Tsai, Knutson, & Fung, 2006). Tsai et al. (2006) differentiate between "ideal affect" and "actual affect". Ideal affect refers to a goal, whereas actual affect refers to a response. Thus according to the affect valuation theory, a desire to be happy is an empirically distinct construct from feeling happy. Ideal affect necessitates understanding of various affective states and their contingencies; actual affect does not. Moreover, the authors claim that since most people want to feel good, ideal affect constitutes primarily positive states, while actual affect constitutes the entire spectrum of affective states. The affect valuation theory predicts that cultural factors shape

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34 Cf. Affect as form of cognition (Duncan & Barrett, 2007).

ideal affect more than actual affect, while temperament has the reverse effect on the two constructs.

6.1.3 Ethics, culture and technology

All societies encode sociocultural practices and concepts circumscribing behaviour and ideas about what is good and bad, as well as what constitutes a good life; that is, ethics. In essence, the study of ethics is the study of how one should live. Ethics or moral philosophy has long been the domain of philosophers. For Aristotle, ethics is a branch of politics. It requires the statesman to create opportunities for citizens to live a good life. As J.A.K. Thomson comments, "It will be seen that the effect of this injunction is not to degrade morality but to moralize politics" (Thomson, 1963, p. 26). Whereas for Confucius, ethics govern the maintenance of social norms and values pertaining to ongoing social arrangements such as the family and the state (Shun, 2013)

In Western cultures, a layperson could encounter ethical issues in the context of business and medicine, as well as in professional standards. The term morality, which is often used interchangeably with ethics, is perhaps more familiar. Morality constitutes the social norms and conventions governing the concepts of right and wrong, good and bad in relation to one's conduct and values. Hence morality is a subject of moral philosophy or ethics. How is ethics connected to culture?

Prinz (2007, p. 185) argues that culture can be the cause and effect of, and the reason for, morality. Culture is the source of moral values. According to this view, people learn conceptions of morality through enculturation, and conformity to various cultural practices including codes of practices. In this respect, morality is a cultural construct. Moral values found in a sociocultural system contribute to the maintenance of the system. One often associates with other individuals who share one's values, and conversely one tends to avoid others who do not share them. Hence shared moral values bind individuals. Shared moral views enable stable cohesion because they impact individual and group behaviour. Morality emerges in sociocultural systems as codes of conduct encompassing collective actions that are necessary for building coherent social groups. Shared moral values influence people to cooperate with each other, and predispose them to avoid harming other members of the community.

One has to acknowledge, however, that applications of moral values have a range of effects from social cohesion, to "revenge killing" in tribal societies (Chagnon, 1988), to genocide.

Concepts of morality are closely linked with religion, specifically religious dogma and practices. Encoded in religious dogma are specifications about what constitutes moral actions and thoughts. As a component of culture, one also finds similarity and differences across religions, variability that also has repercussions for the present discussions on techno-cultural phenomena, design and human-technology interaction. Religious codes of conduct and thought have a relationship with technology, particularly with regards to its

usage and diffusion. Well-known examples include the proscriptions on contraception methods in Roman Catholicism, Eastern Orthodox, Orthodox Judaism, and Islam (Srikanthan & Reid, 2008). Less controversial examples are the proscriptions on watching television amongst the Laestadian denomination of the Evangelical Lutheran Church of Finland (Alasuutari, 1996), and the prescription for leading a simple way of life by using non-modern technology amongst the Amish-Mennonites in the United States (Kraybill, 2003). Religious moral code also have direct impact on the design of technology as in the case of the qibla or qiblah compass, a compass used by adherents of the Islamic faith to determine the *Ka'abah*, the most sacred site in Islam, in order to appropriately position themselves for their daily cycle of prayers (Ibrahim & Norashikin, 2010; Rius, 2009).

The previous presentation on culture, language, and emotion brought up issues highly relevant to an examination of the relationship between ethics, technology, and culture. One could see, for instance, an example of complex intertwining of cultural characteristics in the language of love and hate, and related representations. Conceptions of what constitutes right and wrong have links with the dichotomous feelings of love and hate. Moral concepts are related to emotions (Prinz, 2007). Variability in expressions of emotions and the attitudes toward such expressions have analogues in moral relativism across cultures.

Attitudes towards various forms of violence, for example, vary across cultures. Anthropological literature shows that behaviour considered immoral in Western culture is or has been accepted practice in some other cultures. Consider cannibalism and infanticide. These practices provoke abhorrence in Western societies, yet anthropological records show that cannibalism and infanticide have been accepted practices in many cultures at some point in their history (M. Harris, 1979, pp. 90-91). Consider the action of killing a human being. All sociocultural systems have rules specifying the ethical boundaries of this act, as well as other acts of violence such as rape, honour killing, public executions, torture, and genocide. These rules are based on specifications subsuming actions that follow rules and actions that break them. Hence there are rules, and rules for breaking rules (M. Harris, 1999, p. 23). These cultural artefacts are embedded for example in jurisprudence practiced in different countries. In most Western cultures, the construct of homicide is further differentiated into the constructs of murder and manslaughter. They are dependent on the cognitive construct of "premeditation", and there are cultural variations in the conceptualization and interpretations of premeditated behaviour. Similarly, one finds variation among Western cultures in attitudes towards capital punishment for homicide. Illustrating moral relativism with examples of variability in attitudes toward violence across cultures obviously emphasizes extreme cases in the human repertory of moral values applied to ideas and behaviour.

Morality affects mundane situations in daily life as well. For instance one will find cultural variations in attitudes toward sexuality and marriage. How-

ever, an examination of cultural variability in these constructs quickly leads to controversies regarding the morality of homosexuality and various sexual practices, as well as disputes about the morality of polygamy, polygyny and polyandry (Rehman, 2007; Shah, 2003). As of 1999, 86 countries maintain criminal laws prohibiting or regulating sex between two consenting adults of the same gender (Goodman, 2001). It is clear that co-determination characterize the relationship between culture and ethics. The preceding examples are admittedly extreme cases regarding the application of moral values across cultures to highlight the co-specifying characteristics of culture and morality, and how the variability in the ideational and behavioural application of morality has repercussions on the significance of culture to the human experience. By extension, issues constituting moral relativism impact design and creation of contemporary technology.

Contemporary ethical issues concerning technology are numerous. They have both direct and indirect impact on research, design and marketing of technology. Issues range from product safety to corporate moral responsibility to the morality of producing nuclear energy and genetically manipulated food to research on stem cells. In daily life in some cultures, one confronts the moralization of technology when one makes a conscious choice to walk or take a bicycle to work instead of driving a car; or when communities collectively categorize and separate trash into different bins according to whether the material is biodegradable or recyclable. At the individual level in many Western societies, one is increasingly exposed to ethical issues underlying the production of consumer products from shoes to computers. Is it moral to employ child labour in manufacturing (Hindman & Smith, 1999; Kolk & van Tuldere, 2002)? Should one buy a product that is produced under exploitative working conditions?

The increasing dependence of human communication and commerce on computer technology exposes one to myriad moral issues involving human-technology interaction as well as to the variability in their application across cultures. Anybody who has dealt with the aftermath of computer virus infection, or ”phishing”, that is, the intentional use of electronic mail or websites to deceive others into revealing confidential information such as bank account numbers, would certainly ask about the morality of the perpetrators. There are cases in which activities such as phishing could be the domain of organized crime (Brody, Mulig, & Kimball, 2007). Other activities such as producing and spreading computer viruses (Serazzi & Zanero, 2004), copying and sharing, or counterfeiting and reselling of original music and movies (Peitz & Waelbroeck, 2004), or ”liberating” copyrighted intellectual property (Doctorow, 2013) have ethical dimensions.

On the supraindividual level, much of the brunt of adhering to ethical standards falls on institutes and organizations, and the individuals associated with them. Decisions with ethical dimensions not only affect human interaction with technology, specifically with regards to well-being, they also have repercussions on the environment. Cases involving privacy (see discussion in chapter 3.2.1), workplace standards in Chinese factories manufacturing and assembling

electronic products for Western multinationals (Frost & Burnett, 2007), sales of outdated drugs in Africa (Geshekter & Turshen, 2000; Tren, Coticelli, Bate, & Hess, 2008), and the use of recycled water for irrigation (Laurenson, Bolan, Smith, & McCarthy, 2012) are examples.

In his analysis of Nietzsche's moral philosophy, Prinz (2007, p. 217) suggests lessons that also have implications for the study of moral values as a cultural characteristic: values have a history. This history often involves power struggles and disputable psychological motives. Blindness to this history gives one a false sense of security in values. However, one could change morality and adopt a value system that has advantages over the one into which one has been enculturated.

Separating ethical issues from technical issues is problematic. The separation tends to promote and maintain the unexamined assumption that technology is an inherently good thing for society. With some exceptions, ethical implications are rarely examined during the design and engineering of technology artefacts. These issues come to the foreground only after the introduction of the artefacts into society. Ethical issues can and should be addressed during the design and creation of technology artefacts rather than as an afterthought.

6.1.4 Aesthetics, culture and technology

> It is clear that ethics cannot be expressed
>
> Ethics are transcendental.
>
> (Ethics and aesthetics are one.)[35] (Wittgenstein, 1922, paragraph 6.421)

In the context of examining the ambiguous relation between ethics and aesthetics briefly discussed in chapter 5.3.1.1.1, the parenthetical statement in the above citation provides a philosophical viewpoint, which has been extended by several authors (Bai, 1997; Brady, 2006; Stengel, 2004) to address the inherent ambiguity observed. As previously stated, foregrounding this ambiguity with the aid of a philosophical view allows for a nuanced causal description of the ambiguity's effects on people's choice and prioritizing of values applied to their appraisal and interpretation processes, which are processes of import to conceptualizing human-technology interactions in the context of forms of life.

Every culture evolves and provides a theory of the sublime. While most members of a cultural group might not be able to articulate and explicate much of their culture's tacit concepts of aesthetics, these concepts nevertheless manifest in their values, attitudes and norms, and they are applied explicitly and implicitly as a frame of reference to thinking, feeling, and behaving. In employing aesthetics as a cross-cultural category, the term *aesthetics* is used to primarily talk about the concepts that have evolved in various cultures to rep-

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35 "Es ist klar, dass sich die Ethik nicht aussprechen lässt.
Die Ethik ist transcendental.
(Ethik und Aesthetik sind Eins.)"

resent the sublime. While allusions are made to aesthetics as applied to works of art, the focus of the present discussion is on aesthetics' relation to daily experience.

The usage of the term, in concert with the previously given working definition of culture (see chapter 2.4), applies to material and immaterial culture. That is, the term aesthetics is hereby defined as a representation of the human capacity to make qualitative interpretations in terms of the sublime, in terms of stimuli whose source can be material or immaterial objects including human behaviour, and not limited to objects of art (Morphy, 1992). This conceptualization of aesthetics is akin to Henk Oosterling's characterization of Japanese art as "a-voiding aesthetics". Oosterling notes that Japanese aesthetics is untranslatable in terms of Western (i.e., Kantian) aesthetics, for it does not make a distinction between crafts and arts; it subsumes the aestheticization of actions such as drinking tea, arranging flowers, calligraphy, folding paper, cultivating small trees, and practicing martial arts techniques (Oosterling, 2009). Salient to the present discussion is that qualitative evaluation based on theories of the sublime is applicable to the human perception of artefacts' physical attributes, and non-physical attributes, specifically emotions and metaphors, as well as human actions.

6.1.4.1 Psychological aesthetics

Phil Russell and colleagues specify affective concomitants and consequences as the subject matter psychological aesthetics. In this context the term aesthetic experiences has been used to refer to the pleasurable or displeasurable experience triggered by stimuli that are perceived and interpreted as beautiful or not, rewarding or not. Aesthetic responses are behaviour—such as acceptance or rejection, and verbal expression of preference—linked to aesthetic experiences. (Russell, Deregowski, & Kinnear, 1997, p. 125).

Western concepts of the ultimate aesthetic experience are related to works of art (i.e., visual, music, literature, and oral traditions of telling stories), but there seems to be no fundamental difference between such an experience and an aesthetic experience with any other artefact (Berlyne, 1971).

It has been suggested that the impact of culture on aesthetics could be noted in the historical and geographical differences in styles and conventions in works of art and other artefacts (Russell et al, 1997, p. 126). According to this view, similarities in aesthetic responses are also evident across culture in the sense that works of art are universal amongst cultures. Elaborating causal descriptions and explanations regarding similarities and differences in aesthetic responses across cultures entails relating these responses to the characteristics of culture as well as to other variables manifesting in the different sectors of culture—e.g., economy, social institutions, values and beliefs.

The notion of universal aesthetic responses suggests the possibility of linkage between such responses and the fundamental traits of the human nervous system (Avanzini, 2012; Brattico & Pearce, 2013; Särkämö, Tervaniemi, & Huotilainen, 2013; Zatorre, 2005).

There is a fundamental problem in elaborating causal explanations regarding similarities in aesthetic responses across cultures: acculturation. Russell et al. (1997) argue that it may be difficult to tell whether the observed similarity is due to a pan-cultural factor underlying all cultures, or to the contemporary trend toward homogenization of cultures. Similarities across cultures in aesthetic response to collative variables—for example complexity, novelty, uncertainty and incongruity—could be expected since arousal mechanisms are universal among humans, coupled with the fact that art coming from different cultures all seem to utilize collative properties. However as previously pointed out, drawing general conclusions from similarities in aesthetic response is problematic.

Study of psychological aesthetics subsumes the notion of environmental aesthetics. Russell et al. (1997, p. 133) point out that analysis of the reaction of cultural groups to human-made environments could be used to validate the proposition that the degree of agreement between preferences for human-built environments by different cultural groups will be influenced by the similarity of these environments to the living environment of the groups. This insight has particular salience to conceptualizing extensions to existing forms of life, innovating new forms of life as well as supporting technologies (cf. ecological aesthetics and embedded systems in Yue & Yue, 2013). Examples of applied environmental aesthetics include studies of human factors requirements related to human-built environments (Chan, 2013; H. Lee & Park, 2013).

To summarize: similar to the issue of ethics-framed interpretations presented earlier, aesthetic interpretations of perception cannot be assumed invariant. For instance in the Asian context, Schmitt and Pan observe that aesthetic expressions are framed by three principles: complexity and decoration, harmony and naturalism. Chinese, Malays, and Thais value complexity and decoration through the display of multiple forms, shapes and colours. Harmony and naturalism are considered ideal attributes of the sublime. In China, symbols of natural objects are often present in brand names, logos, packaging, and advertising. In Japan, trees, gardens and flowers have symbolic aesthetics associations (Schmitt & Pan, 1994).

Thus far the connections between culture and technology have been established, and the interconnections between human cognition, emotion, and language have been described. All these constructs have significance for the process of designing culturally responsive human-technology interaction. Both the creator and user of technology artefacts have to deal with issues regarding perception, cognition, emotion, language, aesthetics, and ethics either implicitly or explicitly. In a similar implicit or explicit way, similarities and differences in cultural characteristics across cultures impact the whole process of design of technology. It is far more useful to deal with these issues explicitly.

It has been submitted that culture provides the secondary interface between humans and nature. In contrast, the human structure itself serves as the primary interface. Material conditions in the environment have a circular

causal relationship with culture. This relationship manifests as a by-product of the circular coupling interactions between humans and the environment. Moreover, this causal relationship between material conditions and culture in turn exerts great influence on human actions and cognition. This is not to say, however, that human mind and cognition are merely tabula rasa shaped by the contingencies of nature and culture, nor that human agency does not affect nature or culture. Clearly there is circularity in the causal chain between nature, human mind, agency and culture[36].

Furthermore, it is clear that human agency specifically through the use of technology has produced various impacts on the development of culture and on nature. Consider the various unintentional consequences of human technology on the Earth's ecosystems, for example depletion of the biota, which had already begun in the post-Pleistocene epoch (e.g. M. Harris, 1979, pp. 87-89), depletion of natural sources of energy, pollution, and planetary warming. Moreover, constructs connected to specific technology (e.g. concept of "mutually assured destruction" linked with nuclear weapons technology) in principle clearly carry the power to irreversibly alter the planetary ecosystem should they come to fruition. If culture serves as guardian of continuity/change in human social relations and well-being, technology governs the process. Heidegger (1977, pp. 12-19) argues that technology is not just a neutral or instrumental means; it is also revealing the world that influences the life of all who are involved with it.

6.2 Design relevant attributes

The following sections present descriptions of the categories of design relevant attributes, including their theoretical basis. Included are examples of the most relevant attributes that are fully or partly culture-bound. Then follows a presentation of example questions that should be asked during the analysis of culturally shaped human factors in order to make predictions about preference, performance, and user experience relevant to designing and engineering systems. The term attribute is employed in two senses: (a) As a characteristic of a human being and process; in this sense it is used synonymously with the term "factor" as in *human factor*. (b) As a characteristic of any given technology artefact (i.e., of being and process). These attributes are organized in the rubrics biopsychological, ethical and aesthetic (see Tables 6 - 9).

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36 Cf. the notion of cognition as embodied action and structural coupling in Varela et al., 1991/1993.

TABLE 6 Processes affected by cultural variance.

Attribute	**Dimension(s) of variation**
Perception:	(Note links to aging and disabilities)
Visual – colours, images, form, spatial cognition	Meanings, link of inferential process to ecology, language, cognitive style, and aesthetics
Space	Meanings, link of inferential process to ecology, language, cognitive style, and aesthetics
Other sensory modes (i.e., auditory, olfactory, gustatory)	Meanings, link to ethics and aesthetics
Emotion	Expression (ideal-actual affect), appraisal
Cognitive style	Holistic-Analytical
Categorization:	Holistic-Analytical, links to folk and intuitive theory
Colour coding	Meanings linked to language, emotion and affect terms, religion, ideologies, and taboos
Learning and memory:	Links to ecological-environmental factors
Schooling and literacy	Imitation, memorization, rote styles
Memory	Memory of narratives; links to incidental and intentional learning conditions; recall and clustering
Problem solving	Contextual-Logical
Communication style	Language, metaphoric representation

These are the principal attributes that are relevant in general to human-technology interaction research and design processes; not all of them will be required in every system design project. There will certainly be secondary, tertiary, etc. attributes that need to be accounted for in specific projects. The description of these attributes as well as the relationship between them will have to be translated into quantifiable human-technology interaction requirements that can then be used by designers in their work.

TABLE 7 Human factors and related HTI attributes.

Human factor	**HTI attribute**
Perception:	
Visual	Visual displays, controls, dials, indicators, signs, icons, and diagrams
Auditory	System feedback, e.g. auditory cues, alarms
Spatial cognition	Visual displays, e.g. layout and organization
Other sensory modes (i.e., haptic, olfactory, gustatory)	System feedback
Emotion	Multimodal presentation, narrative
Cognitive style	Navigation through user interface
Categorization:	
Colour coding	Visual displays, controls, dials, indicators, signs, icons, and diagrams
Learning and memory:	
Schooling and literacy	Vocabulary in textual display, documentation, training
Memory	Information presentation, training
Problem solving	Navigation through user interface
Communication style	Text displays, content narratives, documentation, training; amplified, vocoded and synthesized speech

In elucidating the cultural variations and similarities in the design relevant attributes, one has to apply the process to a reference culture (i.e., the researcher's cultural group) and the target culture or cultures.

TABLE 8 Ethical attributes.

Attribute	**Dimension (s) of variation**
Morality	Links to religion and ideologies
Power dynamics – power and authority	Links to domestic socio-economy (e.g., kinship), political economy (income levels, education levels), and taboos.

TABLE 9 Aesthetics attributes.

Attribute	**Dimension(s) of variation**
Somatic:	
Visual	Colour encoding, link to metaphoric representation
Auditory	Sensitivity to high amplitudes, semantics of auditory signals, speech spectrum
Other sensory modes (i.e., haptic, olfactory, gustatory)	Meanings
Emotion and affect	Appraisal, expression, metaphoric representation
Metaphors	Use of spatial and other dimensions (e.g., brightness); links to religion and ideologies

6.2.1 Biopsychological attributes

The term biopsychology serves as a rubric for organizing constructs and related phenomena concerning biological, and psychological processes as they are applied to human-technology interaction. Biopsychological attributes refer to cognitive and behavioural patterns that manifest in the pursuit of fundamental human needs for well-being.

There are of course behaviours and thoughts that are antithetical to the needs described in chapter 5.3.1.1, and a description of these antithetical or dysfunctional factors should be provided in order to get a fuller view of the biopsychological attributes applicable to specific design projects. The following sections describe the attributes perception, emotion, cognitive style, categorization, learning and memory, and communication style.

As previously articulated, the definition of culture used in this work does not take any position on anthropometry as it is used in the study of human factors. The construct racial background would better serve the organization of comparative analyses of them. It is assumed that human factors researchers include in their data gathering project-specific anthropometrical attributes, in which people vary across racial background and national grouping.

6.2.1.1 Perception as meaning making

Much of the phenomena one studies under the discipline of human-technology interaction research concern human perception, particularly regarding the knowledge attained during use of tangible and intangible artefacts situated in a given environment. Perception is concurrently a sensing and meaning making process (Maturana & Varela, 1987). Furthermore the human species can be differentiated from others in its ability to use language for describing perception (Varela et al. 1991/1993, p. 171). This analytical distinction is important for de-

sign purposes. Perception is a product of the continuous multimodal sensing action of an organism in relation to various stimuli within and beyond its structural boundaries (Maturana & Varela, 1987). Sensing varies quantitatively and qualitatively according to the form and function of the organism's sensory organ and processes. Among humans for example, blind and deaf persons perceive the environment differently than persons with full use of their sight and hearing. People experiencing reduced sensory capabilities due to the aging process perceive stimuli differently compared to their younger counterparts. In cross-species comparison, people and dogs perceive light and sound differently in terms of acuity and thresholds for detection. (cf. Varela et al.'s, 1991/1993, pp. 181-83, discussion of the light frequency thresholds detectable by the eyes of animals from different species).

Perception as a meaning making process is universal among higher order primates from the perspective that it is an instinctive functional mechanism for establishing causal relations that have immediate and direct impact on survival (Maturana & Varela, 1987, pp.198-199). One finds an instance of this process in the so-called fight or flight instinct. Perception as a discursive meaning making process, however, is unique to humans. The human species is the only known species that uses language concurrently with cognitive processes to describe perception from the subjective and objective perspectives (Maturana & Varela, 1987). This section concentrates on the analysis of the variability in the meaning making process.

It is important to differentiate how culture, as previously defined, functions in relation to perception. First of all, culture is not a necessary precondition to sensing stimuli. Humans do not need culture to sense for instance hunger, thirst, light or sound. On the other hand, humans tacitly utilize culture to discursively *interpret* sensory stimuli. Hence the sense of hunger might be interpreted to mean time to eat some potatoes or rice; thirst as time to drink hot tea or a cold beer; the sense of a flower as a red or a crimson rose; a musical sound as a screech or a chant.

The process of interpretation subsumes predispositions, on the individual- and group-level, to selectively give attention to certain parts of a stimulus as well as give precedence to one sensory mode over another. In learning environments, for instance, certain individuals might be predominantly visually oriented, while others more auditory oriented. On the group-level for example, Chinese, Korean and Filipino students have been observed to focus more on visuals, while European American students prefer the auditory components of learning situations (C. C. Park, 2001). And since culture constitutes variables including learning, schooling, experience, values and attitudes (Matsumoto & Juang, 2008), it follows that these variables shape perception. The following sections describe primarily the function of culture as a lens (i.e., a prism) used in discursively interpreting perception through the various human senses; that is, learned perceptual inference habits that one uses to describe, and act in the everyday world.

6.2.1.1.1 Visual perception

The process of perception, for all humans, is universal. It is the interpretations of the content that differ because they indicate differences in perceptual inference habits that are shaped by the various ecosystems in which humans live. An early study by Marshall H. Segall and colleagues (Segall, Campbell, & Herskovits, 1963; Segall, Campbell, & Herskovits, 1966) found cross-cultural differences in visual perception, specifically in the susceptibility to geometrical illusions (for general explanations of visual spatial illusions see e.g. Day, 1972). The authors' analysis of data collected over six years in 15 countries indicates Europeans and Americans are more susceptible to geometrical illusions (i.e. the Müller-Lyer and the Sander parallelogram illusions), compared to their non-Western counterparts. They presented the "carpentered world" and "experience with pictures" hypotheses to predict Western peoples' susceptibility to these illusions. They also argued the presence or absence of broad horizontal vistas in the visual environment shapes the habitual visual inference leading to horizontal-vertical illusion susceptibility. Segall et al. (1963; 1966) employ this hypothesis to predict that people living in plains would be most predisposed, while people living in urban areas would be moderately prone, and those living in environments with restrictive sight to the horizon would be least vulnerable to horizontal-vertical illusions.

For reasons not yet well understood, cultural groups differ in ability to perceive pictures (Russell et al., 1997, p. 115). Russell and colleagues (1997) question the viability of the assumption stating pictures constitute a single category that covers all possible type of representativeness. Empirical evidence suggests linear patterns such as obliquity of straight lines have perceptual characteristics that people perceive as pictorial depth even though the pictures evoked by the lines do not represent some material object. There are also cases, for example, silhouettes of objects, and pin-figures, where pictures, which are recognizable representations of three-dimensional objects, are seen as flat pictures. Russell and colleagues explain these two types of pictures represent another continuum, which is subject to cultural influence. The authors suggest that the inverse perspective (i.e. parallel edges are drawn so that they increasingly diverge to convey pictorial depth) used in Byzantine art is illustrative of the case whence cultures utilize certain monocular cues that are unacceptable in other cultures. The authors point out that inverse perspective is viewed as distorted by observers from Western culture.

Empirical evidence also suggests pictorial materials, especially symbols, have to be learned by concrete association with the objects they represent (Mishra, 1982). Empirical findings regarding pictorial perception relevant to human-technology interaction suggest the following: (1) if there is difficulty in pictorial perception as a result of misdirected attention (Serpell & Deregowski, 1980), it should be remedied by instructional method, which enhance the tendency to interpret pictorial cues as signifiers of pictorial depth. (2) Pictorial materials, particularly symbols, cannot be assumed self-explanatory requiring no learning (Banda & Sichilongo, 2006; Lesch, 2003).

If culture as adaptive reaction to various ecosystems shape perceptual inference habits, it follows that one cannot presume people see the world and artefacts in the exact same way. Nor can one assume that the differences remain static through time. While over half of the human global population reside in urban environments (OECD, 2012, p. 17) it is not yet clearly understood how urban spread, that is the spread of the "carpentered world", affects the variations in visual inference habits. It is known however that cross-cultural differences in inference habits regarding the use and meaning of space, and meaning of colours impact human interactions.

6.2.1.1.1.1 Colour perception

Colour affects perceived value of artefacts. This notion is consistent with principle 8 (see chapter 5.2.1.2.3). It has been shown for instance that colour influences the perceived action of drugs, and it seems to influence their perceived effectiveness (de Craen, Roos, de Vries, & Kleijnen, 1996). Colour also has impact on purchase decisions of products (Madden 2000), and on preference for interior colour in interior design (Y. Park & Guerin, 2002). Colour perception and coding, and colour preferences are culturally bound (Choungourian, 1968). But it is not well understood why colour preferences vary from culture to culture. One source of explanation is the cross-cultural study of colour semantics (Jacobs, 1991; Madden, 2000; Ou, 2012).

Evidence of associations of emotions with colour terms, and variations in the associations has been observed in different languages. In Spanish and English, the term green is often associated with envy, whereas in German it is associated with the term yellow. One could find association of red with anger in many languages. In the Thai language, however, an angry person is characterized as one with a body turning green (Soriano & Valenzuela, 2009). There are numerous variations in the semantics of color-coding across cultures, and they are often connected to religion, ideologies, and taboos in addition to affective associations (Gao et al., 2007; Meier, Robinson, Crawford, & Ahlvers, 2007; Meier, Robinson, & Clore, 2004; Sherman & Clore, 2009). Colours associated with sacredness, such as red, blue, white and gold in the Judeo-Christian tradition are different than those of the Buddhist tradition (e.g. saffron yellow), and Islamic tradition (e.g. green).

In order to explicate the effects of culture on color-coding [see principles 8, 10b and 11b], answers to the following questions, at minimum, must be determined.

How are emotions and colour terms associated linguistically?
What are the aesthetics associated with given colours?
How are colours associated with religion, ideologies and taboos?

Color-coding impacts design of human-technology interfaces as for example, in the presentation of different operating statuses of a system. In China, for example, one cannot use the colour yellow to represent a warning status because it is

interpreted as a state of emergency. Furthermore, the colour black is required for representing a normal operating status (Röse, 2004).

6.2.1.1.2 Space perception

Cultures conceive, structure, and use space differently (Hall, 1959/1973; Low, 2003; Munn, 1996) [Principle 8]. Moreover, tacit knowledge and practices regarding space are related to implicit conceptions and usage of time (Hall, 1959/1973). Spatial relations can take on different meanings depending on the cultural context as well as on the context of the domain of action (Low & Lawrence-Zúñiga, 2003). The tacit conventions on personal and inter-personal space when two people are interacting was briefly discussed in chapter 2. Not only do these conventions establish the physical distance that must be maintained, they also elaborate myriad meanings constituting the social distance between people, a space which in turn is founded on temporal distance conceived as a hierarchical interval between them, as for example in the proper social space between an old and a young member of a group (Hall et al., 1968). In some cultures seniority based on age brings higher status and increased possibilities for participating in decision-making (Verran & Christie, 2007). The meaning of this space-time interval permeates the domestic economic organization of groups from families all the way to the political-economic organization of nations. Hence conceptions of space and time include implicit assumptions about intra- and inter-group power dynamics (Bourdieu, 2003; Fernandez, 2003; McDonogh, 2003).

In determining interaction design-relevant attributes, one must examine how space is conceived, and how it is lived in the target culture. One must understand how processes combining social, ideological, economic, and technological factors define the material space, as well as how human interactions, ideations, and daily use of the material environment give it meaning.

Design implications of cultural differences in interpretations of the meaning of space will vary depending on the given domain of action. At minimum, there are implications to the form/function, and placement of artefacts. For example, creators of advertisement shown on television are familiar with national variation in the tolerance for use of advertising space (e.g. Miracle, Chang, & Taylor, 1992).

Culture influences people's reaction to how elements are situated on a printed page, a computer screen, a wall, a room, a building, a city block, a city, in all spaces of human actions [see principles 8, 10b, and 11b]. One should expect that the subtle effects of culturally determined variations in the interpretations could be most problematic. Literature about airline accidents, for instance, points to the general failure in the design process to take into consideration variations in tolerance for inequality in the social space (i.e., hierarchy) reified in the command structure inside the cockpit (Helmreich, 2000). Thus with regard to spatial perception, it behooves the researcher to examine the following questions.

> *(1) How do spatio-temporal concepts manifest in (a) customs and beliefs, (b) family ethics, and (c) folk cosmology and geomancy (e.g., in Chinese culture, these practices extends to food and medicine, feng-shui, naming of individuals accord-*

ing to the Five Elements, and social interactions both in this world and the world beyond) (Y. Li, 1995)?
(2) How are boundaries conceived?[37]
(3) How permanent are they?
(4) How are boundaries marked?
(5) When and how do you know you are inside a boundary?
(6) What constitutes a violation of a boundary?
(7) Is there a hierarchy of spaces (e.g., from most intimate/sacred to most public)?
(8) What is the metaphoric function of a given space boundary?
(9) What are the relevant intervening variables (e.g., age, gender, and socioeconomic status)?
(10) What are the relevant values and values prioritization (Schwartz, 1992; Schwartz, 2013)?

Human elaboration of space involves multiple sensory modalities. What one observes and experiences as variations in the cognitive and behavioural processes of elaboration are by-products of culture's function, akin to the light refraction process of a lens[38]. Culture as sets of inference habits drives its members to selectively pay more attention to particular elements of the environment while at the same time ignoring or de-emphasizing other elements (Segall et al., 1963; Segall et al., 1966).

Implications of the multi-modality of sensing the environment on human-technology interaction design could be made explicit by systematically including in the design process analyses of the requirements of people with disabilities. Arditi and colleagues (Arditi, Holtzman, & Kosslyn, 1988) explain that people with congenital blindness form mental imagery of space just like their sighted counterparts, but their mental imagery lacks the property of perspective. While some aspects of visual imagery are visual, some aspects are multimodal. Tinti and colleagues (Tinti, Adenzato, Tamietto, & Cornoldi, 2006) argue that a lack of early visual experience due to congenital blindness does not impair spatial inference. Visual deprivation during infancy does not necessarily cause incomplete spatial development nor affect future spatial abilities.

While recent research on blindness and space perception helps in understanding the overall plasticity of human sensory and cognitive mechanisms, it should also serve as part of the foundation for culturally adaptive interaction design. People from a culture of disability conceptualize and live in space differently. They have learned to rely on different combinations of sensory modalities to traverse space; that is, modalities different from the ones assumed available to people for executing tasks such as moving from point A to point B. Using a metro system daily to move about in a city has a different meaning. The implications of this difference in meaning must be factored in.

Spatial orientation is partly linguistically structured. Language enables people to conceptualize space and to talk about it. Leonard Talmy noted cases

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37 Questions 2-6 adapted from Hall's discussion of proxemics (Hall et al., 1968).
38 Cf. lens model (Brunswik, 1955).

when culture or language biases individuals toward one way of elaborating space over other possibilities. In effect, the option of selecting a preferred viewpoint is not available to an individual because a linguo-cultural "pre-selection" among alternatives has already been made. This pre-selection enables English speakers to structure differently the space of an automobile and a bus. One gets *into* to an automobile, that is an enclosure, and one gets *on* a bus, that is, a platform. In contrast, German speakers structure both spaces as enclosures. (Talmy, 1983).

Speakers of many Indo-European languages are accustomed to egocentric coding of spatial array; conceptually the planes going through the body give the basis for the intuition about space in terms of up and down, back and front, and left and right. Some languages however do not rely on body-centred notions of space. Instead, they use fixed environment-centric frames of reference such as the cardinal directions or related terms. For example in the Balinese orientation system (Wassman & Dasen, 1998), a direction refers not only to physical but also to cultural, religious and social space. In other cultures certain directions are treated as sacred or preferred. Hall (1959/1973) notes that in the Navajo culture, doors must face east; in Muslim cultures mosques must be oriented toward Mecca. People's preferred frame of reference is connected to language (Talmy, 1983; Tversky & Lee, 1998).

Frames of reference used in spatial concepts could have multiple loci. Linguistic structuring of space can provide clues or markers regarding these locations. The frame of reference for spatial orientation might be egocentric. It might also be allocentric; that is, environmentally, contextually or cosmologically determined.

Understanding (and misunderstanding) the subtle effects of the intangible dimensions of space on human interactions is a stumbling block for interaction design. Take for instance the design of a navigation system installed in an automobile. Representation of the spatio-temporal movement is modelled after an egocentric conception of movement through a Euclidian space. Problems with an egocentric navigation system come up when the locus and focus of movement have to be separated. More precisely, the situation becomes problematic to the target user, that is, a person unfamiliar with a particular terrain and its configuration. In an urban setting for instance a person driving through an unfamiliar city while using a navigation system in a private automobile will get into a problematic situation if some road on the calculated route has been designated for use only by public buses, taxis, and other types of permitted vehicles. The spatial locus and focus in this particular case is contextual. It is evident that a local driver will have no trouble calculating appropriate detours to avoid such excluded spaces because she or he has had ample time to take into consideration their existence. Similarly, a tourist using an egocentric modelled navigation system while driving through Aboriginal landscapes in Australia will unknowingly cross boundaries and enter spaces deemed sacred or dangerous by

Aboriginal people[39] because the navigation system does not take into consideration cosmological and contextual loci of space. The point here is not that a navigation system modelled after egocentric spatial conception is faulty as such. Rather, one has to pay attention to potential conflicts with other culture-bound spatial concepts.

Conceptions of space constitute material and immaterial components. One could analyse them by examining the boundaries that define a given space (Nijs & Daems, 2012; Ozaki & Lewis, 2006). In a built environment such as a house for instance, walls and their attributes define the physical boundaries of spaces, and establish relations between interior spaces as well as between the interior and exterior of the house. Walls constitute the material boundaries. Material boundaries define the physical dimensions of space. Interpretations of the various meanings of the spaces, on the other hand, make up the immaterial boundaries (Heylighen & Strickfaden, 2012, p. 180). They define the metaphysical dimensions. They constitute the invisible boundaries between inside and outside; they determine the idealized aesthetics and ethics of the movements deemed possible or appropriate for the space, of the state of being in the space as a place (Gotved, 2002; Srinivas, 2002). And they determine what material artefacts must be or should be installed to the extent that the metaphysical dimension is reified in the materiality of space.

There are cases where the relations between the functions of material and immaterial boundaries are more complex than the way it has been articulated thus far. In a field study of a Spanish town, David Gilmore notes that the principle of social class is more than a device for categorizing people. It is also a mental map by which human beings organize their natural and fabricated environment. In this case, immaterial boundaries have been projected to the structuring of the physical space of the town to constitute differentiated communities of the living or *barrios*, as well organizing the physical space constituting differentiated communities of the dead: the town's cemetery (Gilmore, 1977).

Depending on the culture, interpretations of meaning and usage of space are valuated along an axis constituting dichotomies such as danger/safety, dirty/clean, sacred/profane, female/male, individual/group, private/public, and many others (Low & Lawrence-Zúñiga, 2003). In other words, spatial delineations manifest in culturally defined rules, hierarchies, and norms. The meaning and salience of these labels for a given culture could be inferred by observing the permeability of the boundaries, the constraints on movements, and the daily practices performed within them. A case in point is the bathroom. While this space is primarily used for washing one's body, the meaning of the space could vary as it is derived from the meaning of the act of washing. In the Japanese culture for instance the act of bathing is a ritual form of purification with a meaning that goes beyond simply cleansing the body of dirt or impurities. Bathing is conceptualized as an act toward achieving both corporeal and spiritual purity. In practice the acts of washing and bathing are two separate

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[39] See Nancy Munn's (Munn, 1996) discussion of Australian Aboriginal spatial interdiction.

processes. Ideally they are performed in different spaces. Elements considered impure are left out of the space for bathing.

Ozaki and Lewis' (2006) examination of plans for Japanese houses shows that bathrooms in Japan are divided into two compartments: a room where one leaves one's presumably dirty clothes, and where one washes before going into the second room to bathe in a tub. Unlike bathrooms in most European or North American houses, a toilet is not installed in Japanese bathrooms. It is instead situated in a separate space. The toilet is associated with the dirty functions of the body and therefore cannot be situated in the space associated with cleanliness. On the other hand, one might find a washing machine in the same space as the one assigned for ridding one's self of dirty clothes and of dirt.

Going back to the case of walls as material boundaries, one could observe for instance the near ubiquitous presence of iron grates on the windows of houses and apartment buildings during a walk through the neighbourhoods of Granada, Sevilla, Córdoba, and Cádiz Spain. This configuration applies to most structures including buildings that are behind high wall-fencing situated on the perimeter of the property. One can infer from this observation that people are generally concerned for their security. The placement, however, of iron grates on windows situated on the second floor (and upwards) makes one wonder about the need for deterrence of burglary or other perceived threat that might come though the windows. Such placements also contradict safety concepts such as using the windows for egress in case of a fire inside the house.

The permeability of the boundaries of the Spanish house could be accounted for by its usage as a sanctuary for the family residing within its walls (Hall, 1959/1973). One can argue that all cultures regard the home as a sanctuary for the family unit. The main point to remember, however, is that the salience of the meaning of safety for the family can vary from one culture to the next, as well as from one family to another. Although the structure of a traditional Spanish nuclear family has changed, it is still the most important unit of domestic-economic organization in the Spanish culture, and the need to maintain its well-being manifests in many dimensions of daily life (Garcia-España, Diez-Ripolles, Perez, Benitez, & Cerezo, 2010, pp. 360-362).

Japanese culture similarly emphasizes the importance of a house as a sanctuary for the family. The walls define the boundary between danger and safety, dirty and clean as well as sacred and profane. Ozaki and Lewis (2006) explain that unlike European families, Japanese families tend to lock out of their houses misbehaving children to prevent them from coming home rather than lock them inside the house to keep them from going out. Constraints on the permeability of Japanese houses are not as visibly obvious. A trend toward concern for personal safety, however, can be inferred from the increased use of security devices such as burglar alarms, security cameras and related services (Johnson, 2007).

Examining mundane domains of action such as the preparation and consumption of daily meals affords a level of analysis for cultural meanings associated with spaces in a domestic residence. Preparing and eating meals are exemplary prototypical activities that give cultural meaning to spatio-temporal di-

mensions. These practices can help draw out relations between the timing of the actions, certain rituals that might have symbolic value (for example whether members of a family must be present at the beginning of dinner), and the person or persons responsible for the realization of the activity (for instance whether food preparation is gender specific or gender neutral). Implications of these relations can affect interactions and other processes such as decisions on what material artefacts are situated in spaces such as the kitchen-dining area or other areas associated with the activity.

A designed or serendipitous intervention into a given space can attract either acceptance or resistance depending on whether it enables people to transcend some unresolved conflict or constraint within the space. For instance the proliferation of multiple televisions in a home might be more acceptable in cultures where individual desire to watch a certain program at a certain time is valued more than a conflicting ideal of the family watching television together.

Interpretation of spatial relations is valuated against some ideal aesthetics and ethics frame of reference that lie along a continuum of the desirable and undesirable. The valuation is articulated as a preference. For instance, space conceptualized as a pause, interval, or silence between sounds takes on different meanings according to a culturally determined aesthetic ideal. The frequency of silence between sounds defines the tempo and rhythm. These are also valuated according to some tacit aesthetics that varies across cultures (Iversen, Patel, & Ohgushi, 2008). One can also observe variations in the notion of musical harmony in different cultures. For someone who has grown up with Western music traditions, non-Western music might sound exotic. On the other hand he or she might valuate it negatively as noise (Russell et al., 1997). Musical consonance and dissonance is a cultural phenomenon (Cazden, 1945, p. 5).

One can also observe cross-cultural variability in preferences regarding the intensity of sound as spatial relation between the desirable and undesirable in built environments such as restaurants and shops. Designers of retail shops, particularly big department stores, attempt to influence purchasing behaviour by including background music in the given space (Caldwell & Hibbert, 2002; Eroglu, Machleit, & Chebat, 2005; P. C. Smith & Curnow, 1966). The choice of music genre as well as music loudness serves to create a positive emotional association with the material space. This choice is also dependent on how people valuate the genre and volume given a particular cultural setting.

The embeddedness of spatial interpretations in ways of thinking enables people to structure space even when it is immaterial. Stine Gotved observes that the notions of space that lies behind the computer screen, particularly the imagined world of online communities are dependent on this embeddedness. Computer related language is loaded with spatial references supporting spatial structuring of the so-called online experience. While the interface space is only a two-dimensional box providing visual stimuli in form of simulacra, it simultaneously provides entry into a human realm full of sociality. This social space represents connections and community, whereas the metaphorical space ena-

bles distinction of the online (immaterial) through analogies, from offline (material) space. (Gotved, 2002).

To summarize, human elaboration of space serves the processes of constructing its materiality, and defines the meanings as well as experiences of the daily interactions realized within it. Space can be conceptualized as a place or territory, a distance or interval, national or transnational, gendered, sacred, private or public. From an interaction design perspective, variations in the interpretations of these conceptualizations problematize design attributes that are assumed as non-differentiated across cultures, but these variations also present potential for innovating designed interventions.

Up to this point the focus has been on meaning making involving visual perception and auditory modes of perception. This is not to deny the importance of human perception through the other sensory modalities. As stated earlier, spatial perception is a multimodal process; this statement also applies to human perception. Hence one should also examine the implications of the haptic, olfactory and gustatory senses as applicable to a given design project because culture-bound inference habits affect interpretation of stimuli through these modalities. Research on olfactory and gustatory modalities from the perspective of preferences has been applied to processed food technology (Birch, 1999; Tuorila & Monteleone, 2009), and pharmaceutics—e.g. the use of flavours (Bandari, Mittapalli, Gannu, & Rao, 2008).

Another case in point is the use of odorants. For instance odorants are added to natural and liquefied petroleum gas to help people smell the presence of these dangerous gases; odorants are also added to products such as cosmetics, cleaning products, and upholstery for car seats in order to impart a certain affective association. Researchers have established that culture can have an effect on odour sensitivity, identification, and representation (Chrea et al., 2004), but the reasons for the similarities as well as variations are not yet well understood. Auditory signals are designed into systems feedback such as alarms, but research on cultural effects on the semiotics of sound applied to warning systems has just recently come to the foreground as auditory signals are built-in to artefacts used by non-experts (Häkkinen, 2010). Further development of the so-called haptic technology requires better understanding of sociocultural effects on emotional and aesthetic responses to tactile sensations as well as the meanings associated to them.

6.2.1.2 Emotion

The issue of universality and differentiation of emotion remains highly contested, but one can view the contradictory findings as two faces of the same coin. Studies of emotion's links to perception and language imply that while emotion is universal to humans, the meaning and interpretation of emotional experiences can vary across cultures [see principle 8]. In the United States, Americans consider emotions to have personal meaning whereas in other cultures, emotions are considered as expressions of the relationship between people and their environment (Matsumoto & Juang 2008, p. 220). Hence when one discusses

with others about one's feelings, one cannot assume nor expect mutual understanding.

Since designers are using knowledge of emotional preference in their work, the use of affective constructs in the design approach necessitates examination of the following questions.

What linguistic differences exist in the interpretation of affective terms?
How are the interpretations connected to ideal aesthetics and ethics values?
What is (are) the metaphorical function(s) of a given emotion?
What are the relevant values and values prioritization (Schwartz 1992; Schwartz, 2013)?

It has been previously indicated that emotions and perception are mutually determined phenomena; they are fundamental elements of cultures along with aesthetics and ethics, and they are connected. Given the observed cultural variability in meanings associated with emotion terms, it follows that emotions-based design approaches have to be supplemented with the details on differentiation.

While the problematic aspect of the methodological framework used in the study of user experience for conceptualizing and analysing emotion should be kept in the foreground, one nevertheless must create an integrative analytical approach that serves to delineate emotion's attributes that are relevant to human-technology interaction design.

Klaus R. Scherer argues that linking folk concepts of emotion to scientific conceptualizations is problematic for the systematic analysis of emotion. Scherer proposes a component process conceptualization in order to distinguish emotion from other affective phenomena such as feelings, mood, and attitudes. Scherer suggests four types of affective phenomena that should be differentiated from emotion: preferences, attitudes, affective dispositions, and interpersonal stances. He describes these phenomena in terms of the design features of the human emotional system: event focus, appraisal, synchronization, rapid change, behavioural impact, intensity, and duration. In addition to serving as a frame for differentiating emotion from other affective phenomena, these design features can also facilitate the creation of semantic profiles of folk concepts of emotions terms from natural languages. (Scherer, 2005).

Scherer (2005) explains the event focus feature of the emotional system refers to the need to anchor emotions to specific internal or external stimulus events that trigger a response after having been evaluated for their significance, rather than something free-floating, resulting from an intentional decision, or being a permanent feature of the individual (cf. synchronization of perception and emotion in Varela, 2000/2003). Examples of external stimulus include natural phenomena like lightning, or other people's behaviour that might have significance for our well-being.

According to Scherer (2005), internal events could be neuroendocrine or physiological changes, or recalled or imagined representations of events. The emotional system is appraisal-driven in the sense that emotions serve as rele-

vance detectors: that is, the relevance of a given stimulus event to the major concerns of humans (e.g., survival) is determined by a complex and rapid evaluation process that could happen at several levels of processing: from automatic and implicit to conscious propositional evaluations. The appraisal process could be further differentiated as intrinsic or extrinsic. Intrinsic appraisal means evaluation of an object, a person or an event independently of the appraisers current needs and goals, based on genetic (e.g. sweet taste) or learned (e.g. bitter-sweet food) preferences. Extrinsic appraisal means evaluation whether a given stimulus and its consequences are favourable to the appraiser's needs, desires or goals.

Scherer (2005) describes synchronization as the coordination of all or most of the human subsystems in contributing to preparing a response to a stimulus event. This feature can be operationalized and measured empirically. Rapidity of change describes the constant modification of emotional processes in order to enable fast readjustment to changing circumstances or evaluations. Behavioural impact pertains to emotions' effects on consequent behaviour. These effects often interrupt on-going action sequences as well as generate new goals and plans. The motor expression of emotion (e.g., smiling, crying, changes in voice volume, changes in body movement) strongly impacts communication. Intensity concerns the potency of the response patterns and corresponding experience. Given the importance of emotions for behavioural adaptation, one can assume the intensity of emotional experience to be relatively high. This feature of the emotional system might distinguish emotions from moods and other affective phenomena. Whereas intensity of response patterns and emotional experience are necessarily high, the duration of response mobilization and synchronization must be conversely low to not overburden the resources of the human system, and to allow behavioural flexibility.

Emotion and affective terms as an index for values and preferences [principles 10b and 11b] have been applied to design methodologies such as kansei engineering, which have been used in several industries such as automobile, fashion and interior design, particularly in Japan and South Korea (Nagamachi et al., 2013; Nagamachi, 1995). The kansei approach employs psychophysiological measurements. Psychological measurements are operationalized by creating semantic differential scales (Osgood, May, & Miron, 1975) of kansei words. Members of a target group are asked to use these terms to describe their feelings about certain design elements, with the objective of converting the semantic differential ratings to useful design parameters. It has been noted, however, that the approach has several weaknesses, which include the lack of consideration for differences in linguistic interpretation of the subjective feeling terms when the approach is employed cross-culturally (W. Shen et al., 2000). Citarasa engineering (Helander, Peng, & Khalid, 2007) is an alternative approach, and it is differentiated by its explicit consideration for cultural dimension of emotion.

Another approach to mitigate the weaknesses is to elucidate the cultural variation in the metaphorical and metonymical function of emotion terms.

Zoltán Kövecses (2000) points out that metaphors and metonymies contribute actively to the structure and content of prototypical cultural models of emotions. And while one can discern structural universality in the models of emotions across cultures, there are variations in conceptualizations as well as linguistic expressions of these concepts. One could explicate cultural models of emotions through the examination of the relationship between the possibly universal experiential basis of a given emotion concept, the conceptualization of this basis by means of conceptual metonymies, the conceptual metaphors stemming from the metonymies, and the cultural contexts. There are no emotion-specific metaphors or metonymies.

Kövecses (2000) argues that variation occurs due to differential framing or to differential experiential focus through time. These variations can be observed in linguistic data. Differential framing means a metaphor can be constructed from different perspectives, and have different meanings. Differentiation can apply to both the source and target domain components of a metaphor. For instance in the metaphor "lust is heat", the physical force of heat is the source domain, while the feeling of lust is the target domain. Linguistic examples of this metaphor in the English language (e.g., "She is burning with desire") demonstrate that the source domain (heat) is applicable to the lust of the person experiencing the feeling as well as to the lust of the person who is lusted after. For contrast, the same metaphor is understood differently when expressed in the Chagga language (a language spoken in Tanzania). Emanatian (1995) gives the example "Nkeóka" (translated in English, as "she roasts"), which is understood as "she is sexually desirable". Differential experiential focus means some aspect or component of universal physiological basis of an emotion concept may receive more attention from speakers of a given language in a given culture, and the salience of this preference may fluctuate through time. Kövecses (2000) explains that while increase in skin temperature and blood pressure are universal physiological correlates of the emotion anger, this universality of experiential basis does not lead to a universally equivalent conceptualization. It seems that metaphors of anger in the Chinese language, for example, is based more on pressure rather than on heat.

6.2.1.2.1 Emotions and human-computer interaction

Affect theory distinguishes between primary emotions and secondary emotions. Primary emotions such as anger, disgust, fear, surprise, happiness and sadness are results of stimulus-response events and they are considered universal (Ekman, 1992). Secondary emotions like anxiety, stress and pleasure, derive from primary emotions, depend on the individual and the context, and are important in human-computer interaction because their effect lasts longer and involves continuous interaction with the environment by the individual (Yammiyavar, 2005).

Faiola and colleagues (Faiola, Ho, Tarrant, & MacDorman, 2011) propose that aesthetic experiences from websites evoke secondary emotional responses. For example, certain combinations of colours and artwork give rise to feelings of trust or distrust (Marcus & Alexander, 2007). These responses can be meas-

ured by asking experiment participants to select appropriate responses from a semantic differential scale as they view websites (Faiola et al., 2011). There is a potential problem, however, in measuring emotions on the aesthetic level of experience when interacting with computers. Emotional experiences on the aesthetic plane in human-computer interactions are different from direct emotional experience because there is a distancing involved (Yammiyavar, 2005). A survey of recent literature suggests that current research activities in cross-cultural information and communication technology design do not attempt to directly address this level of granularity. Instead, researchers sidestep the issue and continue to concentrate on mapping secondary emotions to aesthetics responses when interacting with artefacts and in comparing two or more cultural samples.

6.2.1.2.2 Domain applications of emotions

The use of emotion as a cultural construct in the research method has been applied in several domains to get insights on differences in responses to aesthetic as well as functional elements, and consequently use the insights to propose design guidelines for better understanding, usability and overall user experience. The prominent approach is to quantitatively demonstrate that cultural variables affect emotional responses to aesthetics. In website design research for example, Faiola et al. (2011) demonstrated that South Korean and U.S. participants tended to use sets of emotive adjectives with similar meanings to describe their reactions to website pages, but the design factors used by the participants to describe the home pages contained sets of adjectives with different meanings. Moreover, the sets showed both convergence and divergence in the adjectives used by the two groups. The findings suggest that culture influences aesthetic responses, and cultural differences in responses are complex. Emotion as a cultural construct has also been used to extend the application of the kansei engineering approach to cross-cultural design of mobile phones (K. Chen et al., 2007).

In artificial intelligence research, personality traits combined with cultural dimensions has been proposed as constructs in developing algorithms that enable computers to have human-like "personalities", which include cultural dimensions. Researchers employ theoretical models that are derived by numerical analysis of questionnaires, i.e., the Big Five and Hofstede's cultural dimensions, in the computational values and parameters (Nazir et al., 2009). By numerically defining the culture and personality constructs, artificial intelligence researchers are able to map these values to a motivational system for action, and model cultural variability in expressions of emotions, drives and needs within synthetic agents, with applications to modelling cultural conflict, decision-making and intercultural communication. The use of emotion as a cultural construct has been useful in demonstrating that cultural variables have important implications to the form and function of artefacts, but the practice of correlating cultural factors and design elements might provide an incomplete picture of people's perceived needs and expectations of how they want to be supported by technology artefacts.

While acknowledging that anticipation of user behaviour requires "[b]ackground knowledge of the user target group and its culture and consideration of the *cultural filter* (language, logic, and taboos)…" (S. Shen et al., 2006, p. 848, emphasis in original), S. Shen and colleagues did not explicitly identify a model for mapping this knowledge. They set out instead to realign the desktop metaphor employed in personal computers by creating a garden metaphor, which they claimed to be more compatible with the Chinese sociocultural context, and to have good potential for adaptability to other cultures.

Whether or not one views emotion and cognition as concurrent synchronized processes, one must examine cognitive style in relation to the emotion attribute.

6.2.1.3 Cognitive style

The notion of cognitive style refers to a psychological dimension that represents a person's way of perceiving, thinking, solving problems, learning and relating to others (Witkin, Moore, Goodenough, & Cox, 1977). It is also a theoretical approach for examining the relationship between culture and cognition. Cognitive styles research dating back to the early 1950s has attempted to identify individual differences in cognition that are stable, value free, and related to personality as well as to social relationships. Researchers in applied fields have found that cognitive style could be a better predictor of an individual's success in a particular situation than general intelligence or situational factors (Kozhevnikov, 2007, p. 464). Cognition reflects the cultural context. The findings, methods and concepts from cognitive style research have been applied to cross-cultural studies of cognitive development (Witkin, 1950; Witkin, 1967). These studies predate studies in collectivism and individualism. But while the collectivism-individualism value dimensions have been widely used in cross-cultural usability research, correlating cognitive style to interface elements remains as a minority practice.

A possible explanation for the relative underuse of cognitive style in cross-cultural usability research lies in its status. Kozhevnikov (2007, p. 473) notes that the concept still lacks a theoretical structure and remains unintegrated with information processing theories as well as other psychological theories. Despite this lack of integration, cross-cultural usability researchers, particularly those who are not satisfied with applications of the Hofstede value dimensions, have nevertheless employed some dimensions of cognitive style to gain insight about differences in interaction with information and communication artefacts.

In a recent cross-cultural study of the correlation between cognitive styles and issues of information structures and flow in the mobile phone interface, J. Kim, Lee and You (2007) demonstrated that people's performance and favourable attitude towards a user interface would be enhanced if it matched their cognitive style. To obtain a cultural construct for their experiments, the investigators employed the "holistic-analytic" characteristics of perception as conceptualized by Nisbett et al. (2001). They found cognitive differences between East Asians and Westerners. Differentiation was along the lines of holistic versus analytic thought. Holistic thought characterizes a style of thought that engages

in context-dependent and holistic perceptual processes by focusing on the relationship between a focal object and the field in which it is situated. Analytic thought on the other hand engages in context-independent and analytic perceptual processes by attending to the focal object independently of the context.

According to Nisbett et al. (2001) East Asians tend to explain events by focusing on the background (context) and the relationship between an object and its background, while in contrast Westerners tend to explain the same events by referring to properties of the object. Furthermore, in organizing the world, East Asians are inclined to group objects according to the similarities and relationship among the objects, whereas Westerners tend to group objects based on categories and rules. Hence, East Asians have a more holistic approach to perception while Westerners have a more analytic approach.

J. Kim et al. (2007) hypothesized that cognitive styles in categorization will correlate with the types of menus preferred, and that cognitive styles in task handling will correlate with types of interaction flow. The investigators found significant correlations between the categorization style and menu types, but found no correlations between task handling style and types of interaction flow. As a reason for the results, they speculated that the degree of difficulty in the tasks they presented was not at the appropriate level for finding explicit differences, and the Likert scale statements they used were not situation-specific.

Nisbett et al.'s (2001) model has its critics. Some cross-psychology researchers find it problematic because it emphasizes the influence of philosophical traditions in its explanation for the differences in cognitive styles. Critics find this link speculative and lacking in empirical backing (e.g., Matsumoto & Juang, 2008, p. 129). Information and communication technology design researchers such as Eune and Lee (2009) argue that by using such a model, Westerners tend to stereotype Easterners. Asians' behaviours are assumed similar because of geographic proximity to each other, similar looks, etc. But if one uses Hofstede's (1980/2001) value dimensions model, one will find that South Korea's values are closer to averages found in Latin American countries.

J. Kim et al.'s (2007) work is illustrative of the few efforts to specifically map cognitive style dimensions to preference and performance issues, and to refer to an underlying theory. A survey of the current literature points to paucity in this type of efforts. Most recent empirical studies in cross-cultural usability are of the exploratory type, and investigators tend to assume that cultural variance in cognitive style will be demonstrated primarily by working with cohorts who represent the cultures of interest. Differences are indeed found, but it is rarely clear from the results whether culture was the only determining factor.

For instance, Knapp (2007) examined the effect of using navigational systems with interfaces that do not match the target user's mental models on performance as well as aesthetic responses. In this study, Chinese participants performed usability tasks on systems designed based on German and Chinese mental models respectively, and German participants performed the same tasks on the same systems. Interestingly, Knapp found Chinese users to perform better when working with the system designed based on data on mental models

gathered in China, but did not find an analogous effect among the German users. Knapp (2007) also found that while the Chinese users showed variable performances, they rated the two systems as similarly attractive, whereas the German users rated the Chinese system as significantly less attractive. Knapp (2007) pointed to a potential problem of equivalence regarding the items used in the respective user interfaces. But even if there were no equivalence problems in the methodology, it is difficult to explain this type of result without reference to theory. A similar problem manifests in a study by Lin et al. (2007). Their result seem to suggest that cultural background is of significant importance on how users identify the functions associated with and assigned to icons in an Instant Messaging application, but there was no explicit use of any cultural construct that can be linked to variability in perception.

The physiological mechanism of human information processing is universal and could be considered culturally independent. Interaction with the world requires pattern recognition. People understand the constant sensory input through active selection, ordering, synthesis, and interpretation processes. However, the organization and structure of information are affected by the individual's experience, and therefore by culture, which affects experience. Designers have used objects, symbols and gestures as a source of design inspiration. They are often used as metaphoric representations. It is important to note, however, that metaphors are given different meanings by different cultures. Recent examples from the literature are the icons used in the iPhone, such as an U.S. motorway sign to represent a map, etc.

6.2.1.3.1 Categorization

Variations in cognitive style involving categories can impact people's preferences in the organization of representations (e.g., functional commands of a software) in an artefact's interface [see principle 8]. Hence at least the following questions must be addressed.

What is the preferred style of categorization (e.g. holistic-analytic)?
What is the prototype associated with a target affective category?

Categorization refers to people's unconscious cognitive ability to recognize entities in the environment and place them in categories. Categorization takes place via all sensory modalities, i.e., people categorize sounds, smells, tastes, skin sensations, physical movements, and subjective experiences including emotions and thoughts. It is the process serving as a go-between perception and cognition. According to the computationalist model of cognition, after a perceptual system acquires information about an entity in the environment, the cognitive system places the entity into a category. For example an entity perceived by the ears might be categorized as the letter *b*, or an entity perceived by the eyes might be categorized as a *chair*. Categories are representations. In the cognitive system, they are structures that stand for perceived entities in the environment. (Barsalou, 1992).

The actual form of a representation in the brain need not look anything like its referent or linguistic label. For example the brain represents *chair* states defined over large populations of neurons, and not with brain entities that literally look like a physical chair or the linguistic label "chair". These brain states are representations in the sense that they stand for their referents in the environment and can be manipulated by cognitive mechanisms that reason about the environment. The representations assigned to the entities during categorization may be stored in memory, combined with other representations, transformed into new representations, and trigger cognitive processes, such as the intention to achieve a goal. Most cognitive processes begin with some form of categorization. (Barsalou, 1992).

Human knowledge does not follow closely a logical form. For example Hampton (1982) suggested that similarity, not logical principles, controlled people's decision about category membership. Holyoak and Glass (1975) further suggested that availability (i.e. readily available/not readily available) of knowledge about properties of categories during retrieval determines people's decisions about category membership.

Barsalou (1992) proposed that a definition of "concept" includes examples, prototypes and rules that determine category membership as well as the conceptualization of categories underlying understanding, prediction and action. Conceptualizations of categories often fail to provide categorization rules because they serve goals other than determining category membership.

This proposal has two implications: (a) In conceptualizing a category for an "ideal" feature/function of an artefact, a designer can "force" a certain conceptualization onto others. (b) This means that whenever there is a failure in category conceptualization, this event might indicate a potential for intervening with technology-supported actions.

Does culturally mediated learned automatic processing interferes/enables conceptualizations of categories? For example as related to the Stroop phenomenon (Stroop effect)—i.e. once a particular stimulus has been encoded by the cognitive system, people might automatically activate information associated with it. Hence people from Western cultures could have difficulty associating the colour white with death (as opposed to the colour black) in contrast with people from Asian cultures.

The process of categorization is universal to all humans (Rosch, 1999), but the way people categorize artefacts can be culturally variable. Some categories seem to be universal. Facial expressions of the basic emotions happiness, sadness, anger, fear, surprise and disgust are similarly categorized across cultures. There are variations in linguistic representations of colours, but there is agreement across cultures regarding the grouping of colours around the same primary hues. Cultural variations in cognitive style involving categories have been observed in studies of sorting tasks (Sheikh et al. 2009) and prototypes. A prototypicality analysis in which people from different cultural groups are asked to rate the goodness of an item as an example of a particular category would be useful in explicating the variations in preference (cf. usage of semantic differen-

tial rating of kansei words). One could also analyse the relationship between culture and categorization style with the concept of holistic-analytic perception proposed by Nisbett et al. (2001). A holistic approach to categories means grouping artefacts according to their contextual or functional relationships, whereas an analytic approach means grouping according to their properties such as colour, shape or function.

People vary in the way they create conceptualizations of categories. The findings of cognitive psychologists explain this variability through the phenomena of lag effect, context dependency of properties, graded structure, conceptual combination, and intuitive theories. Salient to cross-cultural studies of categorization is the notion of intuitive theories. According to Barsalou (1992) cultures can differ in their intuitive theories. For example, cultures put whale in the fish category (instead of mammal) if their intuitive theories state that shape, habitat, and locomotion (versus physiological and genetic properties) are important to forming categories. People do not rely on information obtained from bottom-up processing to determine similarity. Top-down processing that project theories of nature and human activity onto the world greatly constrains similarity.

Varela et al. (1991/1993) have posited an enactive view of categorization, which provides an important insight into the perception of form/function of an artefact:

> "The basic level of categorization, thus, appears to be the point at which cognition and environment become simultaneously enacted. The object appears to the perceiver as affording certain kinds of interactions, and the perceiver uses the object with his body and mind in the afforded manner. Form and function, normally investigated as opposing properties are aspects of the same process, and organisms are highly sensitive to their coordination. And the activities performed by the perceiver/actor with basic-level objects are part of the cultural, consensually validated *forms of the life* [emphasis added] of the community in which the human and the object are situated—they are basic level activities" (Varela, Thompson, & Rosch, 1991/1993, p. 177).

The relevance of cognitive style to design is connected to its relevance to task and learning performance. An important corollary to the study of cognitive style deserves mention at this point: investigating the effects of culture on cognition cannot be accomplished by simply observing the behaviour of members of cultural groups as they perform some specific cognitive task. One must also analyse the target group's cultural life, the behaviour competencies required of the group's members within the boundaries of their cultural setting, and the way they are nurtured in the course of individual development (Mishra, 2001).

As previously noted, one of the weaknesses of methodology used in recent cross-cultural empirical work in usability testing particularly in the field of information and communication technology is to assume that concepts and materials used in test instruments for one culture is directly applicable to another culture. Already several decades ago cultural psychologists insisted on ethnographic analysis before experimentation to identify activities that people are familiar with and thus should be skilful in dealing with them. If experiments are set up for subjects to demonstrate the usage of skills, then failure to apply

skills, which the investigator assumes natural in given contexts, becomes a fact to be explained through further study and experimentation. Ethnographic work sets a goal for the experiments by setting a cultural base to ensure the meaningfulness of the experiment to the subjects and a benchmark against which one can interpret the adequacy of conclusions (Cole et al., 1971, p. 217). Analysis of cognitive style regarding the processes of categorization, learning and memory, and problem solving has the most salient implications on design. Cognitive style is known to impact technology usage in decision-making, hypermedia navigation strategies, and overall usability of software interfaces (Calcaterra, Antonietti, & Underwood, 2005; I. Chakraborty, Hu, & Cui, 2008; Dufresne & Turcotte, 1997; Faiola & Matei, 2005).

6.2.1.3.2 Learning style

Questions that need attention to explicate the learning preferences [see principles 10b and 11b] of a cultural group include the following.

> *What are the major and minor preferred perceptual learning modalities of the target culture?*
> *How are instructions and feedback given?*
> *What is the common vocabulary used by members of the target culture?*
> *What language conventions are used?*
> *What are the motivating factors for learning?*
> *What are the relevant values and values prioritization (Schwartz 1992; Schwartz, 2013)?*
> *What are the relevant intervening variables (e.g., age, gender, socioeconomic status)?*

Learning style refers to "the composite of characteristic cognitive, affective, and physiological factors that serves as a relatively stable indicator of how a learner perceives, interacts with, and responds to the learning environment. "…Its basis lies in the structure of neural organization and personality which both moulds and is moulded by human development and the learning experiences of home, school, and society"[40](Keefe and Languis, 1983 as cited in Keefe & Ferrell, 1990). Culture reflects the way one learns because culture is learned and shared behaviour. Hence learning can be considered as one of the basic activities of life. People who grow up in different cultures learn differently. Some learn by rote and memorization, while others do so by demonstration, but without being required by the teacher to do anything (e.g. Joy & Kolb, 2009). In some cultures, teachers emphasize learning by doing, while other cultures do not. Once people learn to learn in a certain way, it is difficult for them to do it in some other way (Hall 1973, p. 48). Variation in learning style has been shown to affect technology artefacts such as computer-mediated conferencing and computer-based

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40 The given definition is one of several that have been proposed. For a review of other definitions of learning style in the literature, see e.g. Sywelem, Al-Harbi, Fathema, & Witte, 2012.

learning systems (Fahy & Ally, 2005; C. H. M. Lee, Cheng, Rai, & Depickere, 2005; Nam, Kim, Smith-Jackson, & Scales, 2005; Price, 2004).

In societies, the educational system and parents are primary agents responsible for learning. Parents and educators pass to the next generation the ways of learning that they have learned including prejudices and convictions about particular styles of learning. Edward T. Hall (1959/1973, p. 51) points out that North Americans tend to place more value on a person who learns fast over one who learns slowly. In contrast, other cultures put less emphasis on speed and more on learning correctly.

Research with children in the U.S. has noted that learners access at least four perceptual learning modalities: visual learning, auditory learning, kinaesthetic learning, and tactile learning (R. Dunn, 1983; Reinert, 1976). Within the same national context, researchers estimate that between 20 to 30 per cent of school-age young people are auditory—they learn and remember what they hear, approximately 40 per cent are visual, and 30 to 40 per cent are either tactile/kinaesthetic, tactile/visual, or some other combination of the four perceptual learning modalities (R. S. Dunn & Dunn, 1979). Experiential learning theory[41] decomposes learning into four processes: concrete experience, observation and reflection, formation of abstract concepts, and generalization and testing. Patterns of ways (i.e., learning styles), in which people employ these processes, are organized under the rubrics convergers, divergers, assimilators, and accommodators, and these rubrics are used to describe and classify learners (Kolb, Boyatzis, & Mainemelis, 2001).

A number of cross-cultural studies of learning style suggest variation in preferences for learning styles across cultures within the multi-cultural context of the U.S. (R. Dunn, Gemake, Jalali, & Zenhausern, 1990; Joy & Kolb, 2009; C. C. Park, 2001; Reid, 1987). C. C. Park (2001) also observed cross-cultural variation in preferences for group or individual learning as well as gender differences in preference for kinaesthetic and tactile learning: secondary school aged girls showed higher preference for kinaesthetic learning compared to boys, whereas boys had higher preference for tactile learning compared to girls. Joy and Kolb observed that culture, level of education and area of educational specialization have the most impact on learning styles (Joy & Kolb, 2009). In the Japanese context, Ken Hyland suggests that while Japanese learners have no major preference for a perceptual learning modality, they have minor preferences for the auditory, tactile, and kinaesthetic modalities as well as the individual learning style (Hyland, 1993). Saudi students have demonstrated a preference for auditory learning (Sywelem, Al-Harbi, Fathema, & Witte, 2012).

Learning models are complex systems. They differ across cultures, and children begin to develop them early in life. Understanding these beliefs about learning can help in explaining people's motivation for and ultimate achievement of learning in diverse cultures. (J. Li, 2002). Paying attention to learning

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41 Experiential learning theory is one of the several proposed model for the analysis of learning styles. Cassidy (2004) and Hawk and Shah (2007) provide reviews of current models.

models has direct application to instructional design (whether or not it is technology driven) in learning environments.

The concepts of formal, informal, and technical learning (Hall, 1959/1973, pp. 68-72) are instructive for organizing the analysis of the effects of various learning types on an instruction design project. Formal activities are taught by precept. For instance an adult might teach the young according to patterns he or she has grown up with and never questioned. In informal learning, groups of related activities are learned, and in most cases without the knowledge that they are being learned, or that there are rules or patterns governing the activities. Technical learning is characterized by explicit transmission from the teacher to the student either orally or in writing. It is often preceded by logical analysis and proceeds in an outline form.

While most people go through the education system not consciously aware of the specific ways of learning into which they are enculturated, many encounter cultural variations in learning when they start to travel as a tourist, as a student in an international exchange program, or as a worker for a multinational organization, and in which work involves training local people. Culture, gender, age, level of education, and specialization collectively contribute to variance in preference for learning style (Joy & Kolb, 2009). The empirical works reviewed in this section suggest that learning style is malleable although it is not clear how much (Hyland, 1993).

Given that people are capable of adapting their learning abilities to given situations, the salient implication of empirical findings is cultural conditioning of learning styles can clash not only with the teaching styles of professional teachers but also with the learning and teaching styles embedded in technology artefacts. With the proliferation of the so-called self-explanatory technologies, more and more people encounter the implications of variations in learning style, usually through the experience of frustration with not being able to use a given artefact properly. Paradoxically the implications to design of human-technology interaction of the complexity of culture bound learning style are often overlooked in instruction design, and only fairly recently that researchers have begun advocating increased awareness of the cultural factors. Related to the concept of learning style is the habitual mode of solving problem.

6.2.1.3.3 Problem solving

The introduction of new technology generally presents new contextual problems [see principle 14b] because it requires people to reason about unfamiliar artefacts. Hence the following questions must be addressed.

> *How do members of a given cultural group make connections between a new task and prior knowledge?*
> *What cultural funds of prior knowledge (including content, strategies, inference habits) are available for possible connection to a new task?*
> *What are the relevant intervening variables (e.g., age, gender, socioeconomic status)?*

Cultural groups have been observed to vary in their style of discovering ways to achieve goals, which do not appear to be readily attainable (Cole et al., 1971). Cross-cultural research into the learning and problem solving processes suggests that the variations are linked to the ecosystem in which cultural groups live as well as to the learning style and schooling practices that are dominant in the group (Hyland, 1993; Melton, 1990; Nuzhat, Salem, Quadri, & Al-Hamdan, 2011). Similarities and differences in inference habits across cultures concern content and application of logical rules to technology artefacts. They have implications on the use of reasoning in various daily life situations into which unfamiliar technology is introduced.

In some cultures, people's logical reasoning to solve problems is highly dependent on context rather than in accordance with some general scheme of logic. For instance in a seminal study on inference, Cole et al. (1971, pp. 204-212) observed that when Liberians are presented with problems using familiar materials and concepts, they easily drew logical conclusions. When the problem situation is alien however, they had difficulty in figuring out where to begin. To the nonliterate participants in the study, this latter situation appeared both confusing and frightening, causing reluctance to manipulate the materials used in the experiment. The initial pilot study was a replication of a previous study done on American children. The investigators even borrowed the same apparatus used in the previous study. It was a metal box with various buttons, panels and slots. After instruction in how to work the apparatus, subjects were asked to figure out how to open the device to get a prize that was inside one of the panels. The solution required combining two separately learned solutions to sub-problems: by pressing the correct button to release an object (either a marble or a ball bearing depending on the instructions given), and then inserting the object into the slot on the door of the panel containing the prize.

The remarkable reticence in using the apparatus and poor performance of the Liberian test participants relative to their American counterparts led the investigators to create an equivalent test. In the second experiment, however, they used matchboxes each containing differently coloured keys, and a small box with a lock. This box contained the prize. The results of this study showed greatly enhanced performance on the inference task as well as a general and spontaneous willingness to work with the objects. A third experiment, in which the investigators combined the two previous experiments to test the effects of familiarity with components involved and prelearned connections, further supported the familiarity hypothesis.

Two conclusions from Cole et al. (1971) are relevant to the analysis of cultural factors involved in reasoning about technology. First, a cultural comparative study must ensure equivalence in the meaningfulness of the experiment to the subject. Otherwise it can be difficult to decide among various explanations regarding findings. Second, there is cross-cultural similarity in the relation between problem structure and problem difficulty. In situations where problem solution requires people to combine separately learned sub-problems, they should not experience difficulty in doing so if the elements of the problem are

familiar, or do not induce fear. These observations have implications both in the inter-cultural and intra-cultural contexts. Within cultures, people of a subculture (e.g. elderly cohort) might have more difficulties with an unfamiliar technology if it requires inference skills that are inappropriate. There are situations when familiarity with the problem elements as well as possession of appropriate inference skills does not help in avoiding frustrating experiences with technology. Consider for instance the amount of effort that is required to learn a new version of computer software, in particular when one is forced to search deeper into the command menu structure for a familiar function.

One can infer that people from cultures whose members have grown up with and have been enculturated in a Westernized school setting are more familiar with logical reasoning that is abstracted from context. This does not mean that people from cultural groups that are unfamiliar with this cognitive style are incapable of logical reasoning. Rather, they do not understand a problem space that employs unfamiliar materials and concepts. Neither do they necessarily view the nature of problems with the same degree of importance (Winschiers & Fendler, 2007), nor do they habitually communicate their perceptions and understanding in the same way (Clemmensen, 2011).

6.2.1.4 Communication style

As previously mentioned, cultural variations in communication style manifest in communication technologies (e.g., blogs and social networking). It has been suggested that in human-technology interaction, even a minimum level of social cues in an interface or technology artefact can cause people to treat the artefact in a way psychologically similar to how they would treat another human (Reeves & Nass, 1996). Hence it follows that alignment between the communication style predominant in a target culture and the style represented in an artefact will be conducive to better usability and experience. The following issues must be examined in order to make explicit the variations in communication style [see principle 11d] and the possible implications.

What is the dominant communication style in the target culture(s)?
What characteristics of the spoken language are salient to the preferred style?
How is a given style related to preferences for visual representations (e.g. icons versus text)?
What is the aesthetic function of metaphors in the target language?
What are the relevant values and values prioritization (Schwartz, 1992; Schwartz, 2013)?
What are the relevant intervening variables (e.g., age, gender, socioeconomic status)?

Peoples' communication styles are based on learned patterns of interaction derived from norms, rules, and values of their culture. The styles used by individuals vary from culture to culture. One approach to explain variations in communication style is Edward T. Hall's (1976/1981) differentiation between high-

and low-context communications. Members of a cultural group use both high- and low-context communications, but one style tends to dominate. These ways of communicating correlate to cultural individualism-collectivism. That is, low-context communication dominates in individualistic cultures, whereas high-context communication is used predominantly in collectivistic cultures (Gudykunst et al., 1988). Gudykunst et al. (1996) suggest that independent self-construal and individualistic values mediate the influence of cultural individualism/collectivism on the use of low-context communication, while interdependent self-construal and values mediate the effect on high-context communication.

Language and rhetoric elements that are aligned with the communication style of the target user improve usability. Beyond language differences, communication is influenced by the speaker's cultural background. Cultures vary along the dimension of contextual knowledge that a speaker is expected to have in order to communicate effectively. Messages are conveyed, either implicitly or explicitly, according to the accepted norm on context. A user's cultural identity pervades on-line self-representation, influencing communication style and design preferences. In virtual spaces such as blogs, for instance, British students tend to express their emotions more explicitly and to use a more informal communication style characterized by colloquial words, compared to Chinese students. Chinese students, on the other hand, place more importance on non-verbal communication and used more images. Chinese students also disclose less personal information (De Angeli, 2009). Cassell et al. (2009) found that virtual peers designed in alignment with the linguistic style of African American children in the third grade encouraged code switching and modelling of appropriate science talk in the classroom. Cultural factors mediate online interaction behaviour as well as preferences about using communications technologies to exchange ideas (Amant, 2005). The use of culturally aligned metaphors and symbolism also contributes to usability (de Castro Salgado et al., 2011; Heukelman & Obono, 2009; S. Shen et al., 2006). Differences in preferences for communication style could be explained by the underlying differences in cultural variables, e.g., between individualistic and collectivistic cultures, and low versus high-context communication style (H. Li et al., 2011).

Design issues surrounding the use of metaphors in visual aesthetics also touch the use of metaphors in language and rhetoric deployed in artefacts. Language might not determine what people think about the world but it might affect how efficiently they think about it. The ability to think efficiently about the different domains of the world might reflect the extent a culture has developed words for all the concepts that people must manipulate in thought. However, not all thought uses linguistic expressions; for example when people use imagery in thought, linguistic expressions might play a role (Barsalou, 1992, pp. 272-273).

In addition to the known issues in the so-called internationalization process (i.e., considerations for differences in alphabets, local writing style, and translation), the process of aligning communication styles must be applied to

linguistic and visual components of an artefact. In terms of the linguistic components, both oral and written, one has to consider the characteristics of the spoken language (e.g. accents), and presentation of content particularly involving technical words that might have been invented using a specific language. Menus, images, and icons used in computer software are examples of visual components that require communication style alignment. Use of non-local images, orientations and placement of pages as well as use of icons based on metaphor has been sources of cultural misalignment (Barber & Badre, 1998; S. Shen et al., 2006).

Thus far the unconscious processes of perception, emotion, cognition, and communication have been described. Although the discussion has been structured as if they are discrete sets of the biopsychological category in order to organize their analysis and to make explicit their cultural components, one must view them as synchronized interrelated processes rather than as discrete and serial. As submitted earlier, the biopsychological attributes are connected to the ethics and aesthetics attributes.

6.2.2 Ethical attributes

As with the other design relevant attributes listed in this chapter, explicating the relevant ethical factors [see principles 11c, 11d, and 14b] has to be applied to both the reference and target culture. The following questions must be addressed.

What are the social norms, rules and values (e.g. pertaining to on-going social arrangements such the family and the state) that must be addressed?
How do these norms, rules and values manifest in technology usage?
What are the relevant ideological and religious concerns?
How are the codes of conduct related to religion, ideologies, and taboos?
What are the privacy concerns?
When is it acceptable to breach codes of conduct connected to privacy?
What is the dominant attitude toward disclosure of intended outcomes?
Who are the relevant interest groups?
What are the characteristics of the power dynamics between the different constituencies?
What are the restraints (e.g., taboos) used to support the power dynamics?
Who controls access to the relevant resources?
What are the relevant intervening variables (e.g., age, gender, socioeconomic status)?

Systems designers and engineers as well as the technologies they create are sources of methods and processes that have ethical implications. If one accepts the notion that technology is laden with value—that is, no technology is value free or culture free, then one must also acknowledge that it is not autonomous of the ethical impositions within the sociocultural space in which it is or will be

situated. The main issue is how to reasonably predict intended outcomes as technology is transferred from one culture to another. "Intended outcome" means an intended result that can be attributed to a given causal chain of events as realized through the use of a technology artefact.

One can reasonably predict whether an intended outcome envisioned for a given technology will or will not be aligned with the ethical requirements of a target culture. Unintended outcomes of technology usage due to cultural variation in ethical factors are generally difficult to predict; however, case histories of unintended or emergent usage of similar or previous iteration of a given artefact in connection to well-known issues, such as differences in the norms and rules governing privacy or the political economy, can be employed in the research process and in predicting outcomes related to these issues. For instance, an examination of ethics related to the political economy of China could have helped designers and engineers of social media applications, such as YouTube (Helft, 2009), predict the rejection of these applications by the Chinese central government.

At minimum, one has to examine the ethical issues touching practices and customs connected to religion, ideologies, domestic socio-economy, political economy and taboos, and the power dynamics associated with these components of culture.

6.2.2.1 Practices and customs

The problematic nature of separating ethical and technical issues related to technology development and usage has been discussed earlier. Separating the two issues implicitly reflects and maintains a fundamentally culture-centric view that technical artefacts are autonomous of the social narratives in which they are inserted. Technological artefacts have been used as symbols for certain forms of society [principle 8]. This metaphorical function in turn enables categorization of societies and nation-states according to their technological prowess. Bloomfield and Vurdubakis (1994) point out that claims of inherent superiority of certain technology artefacts over others makes possible the hierarchization of societies as advanced or backwards, and this activity legitimizes the dominant role of technologically advanced societies in the hierarchy. In other words, technical roles are translated to social roles (Bloomfield & Vurdubakis, 1994). Formation of hierarchy based on technical metrics applies at the intra- as well as inter-cultural levels. Members of a cultural group can be labelled advanced or backwards based on their usage of technology.

It is suggested that the boundary separating the technical and the social could be characterized as a sort of black hole wherein possibilities for discourse disappear. It is often reified in the domestic and political economy with the support of ideology (inclusive of aesthetics), religion, and taboos (Douglas, 1966). It is almost understandable why discourse on the ethical dimensions of a technology project often happens only after the technology artefact has already been introduced in the sociocultural realm. Few are willing to cross the boundary. For instance in the field of information and communication technology, there seems to be much interest in the so-called augmented reality applications

(Azuma, 1997). The practice of "tagging" or creating information, related to some object and accessible only through some device, is promoted as a good and useful thing for it helps friends and acquaintances share knowledge about objects of mutual interest (Langlotz, Regenbrecht, Zollmann, & Schmalstieg, 2013). Some of the current popular applications of augmented reality technology include tagging restaurants with recommendations, or a given building with information about apartment rental availability. There is paucity, however, of analysis and discourse on the ethical implications of this practice. What are the repercussions of such a practice as one moves from one culture to another?

Consider the case when people responsible for public transportation systems decide to introduce a new technology for collecting payments from users of the system. In June 2001, a ticketing (fare collection) system constituting databases, telecommunication, computerized sensors and so-called smart travel cards was installed in the public transportation system of the Helsinki metropolitan area (consisting of the cities of Helsinki, Espoo, and Vantaa) in Finland. The technical role of the system was rationalized in terms of efficiency. It serves the efficiency requirements for collection and accounting for money paid by customers as well as collecting information about the usage of the transport system. This information was envisioned as input into the various decision-making processes of the government authorities responsible for the development and maintenance of the system.

At first glance, the rationale for introducing the new technology is both reasonable and sensible. However, there was hardly any public discourse with regard to the social role of the system as it was originally designed and implemented. The system includes smartcards containing personal information (e.g., personal identification number) about the individual who acquired the card as well as information on the monetary value electronically assigned to the card. Until 2003, these data as well as passenger usage data extracted from the sensor device installed in each vehicle in the system were collected into databases. Hence one can extract from the database information on the presence and movement of individuals—the identities of persons riding in a given public transport vehicle at a given time, as well as the time and place from which a person got on a bus, tram, metro or train (Koponen, 2002). The salient point for the present discussion is that information about the technical capabilities for surveillance of individuals first came to public awareness through the newspaper article by Koponen (2002), over one year after the introduction of the new system. By this time the data protection ombudsman, an authority connected with the ministry of justice but operates independently, got involved in the case. The Helsinki Metropolitan Area Council, which is responsible for the public transport system, eventually petitioned in January 2003 the Finnish Data Protection Board, also an independent authority affiliated with the ministry of justice, for permission to collect information on the customers of the transport system (Tietosuojalautakunta, 2003). The outcome of the nine-month legal process ex post facto of the technology introduction: the Council decided to re-configure the system so that data on usage events are not collected, and to destroy the

data previously collected. The data protection board ruled that the public transport authority has the right to collect information on customers within the bounds of Finnish data protection laws.

It is instructive to note that the system is also employed to control usage of the smart travel cards and therefore restrict the actions of the system's users. There are two types of cards available: a personal card, which contains personal data, and a multiuser (*haltijakohtainen*) card that does not contain personal information. The county government subsidizes the price of the personal card. By default, a sanction in the form of a fine is levelled against usage of the smartcard other than by the person whose identification number is encoded in the card, whether or not this type of usage is done with permission from the card's owner. This function was designed to prevent unauthorized use of the card, but this activity can be prevented only if the card is reported stolen or lost, or if the unauthorized user is stopped during a random audit of all the passengers in a given vehicle.

In contrast, the public transport system used by the present author in Granada, Spain (as a registered resident of the county) employs a similar fare collection system, but personal identification data is not encoded in the smartcards. In Sydney, Australia the general public was made aware about the surveillance capabilities of a similar travel card system prior to introduction of the technology (Wood, 2011).

There is no logical reason for leaving analysis of ethical factors, inclusive of cultural variation, outside of the systems design and engineering process. Professional codes of ethics and conduct already exist to serve as a reminder about what is at stake (e.g. ACM, 1992). Maintaining a boundary between the sociocultural and technical roles of technology, however, makes reasonable predictions of outcomes more difficult, thus often forcing both ethicists and technologists to deal with the effects post hoc. Instead, redrawing the boundary to encompass both roles could facilitate application of a systematic approach to analysing cultural variation in relevant ethical domains as part of the design process. This approach is applicable to the aesthetic attributes of culture as well. And in a similar vein, examination of the cultural aesthetic function of artefacts must also be integrated in the design process.

6.2.3 Aesthetic attributes

Cross-cultural studies of technology artefacts such as websites also suggest significant variation in visual aesthetics (Faiola et al., 2011; Mushtaha & De Troyer, 2007). The research challenge is to capture the relevant details of human aesthetic requirements inclusive of cultural variations. Examples of questions that must be examined with regard to aesthetics have been included in the previous discussion on perception and emotion, and thus will not be repeated in the following sections. Cross-cultural examination of aesthetics provides human-technology interaction researchers a way to describe and explain variance in biopsychological attributes: namely perception, emotion, and communication

style. It also enables researchers to describe the connections between these attributes through the study of metaphoric representations of their constituent concepts (cf. aesthetics of interaction in Petersen & Jacob, 2008).

6.2.3.1 Visual aesthetics

The positive aesthetic experiences derived from using artefacts play an important role in the acceptance as well as in the eventual diffusion of an artefact (Tractinsky, 2004). This knowledge has been applied to the design of contemporary products ranging from automobiles to mobile telephones. The information and communication technology development community is well known for its focus on the functionality and usability of their products, especially software, but work on aesthetic issues is often given limited resources or largely ignored (Hong, 2011). However, information and communication technology researchers are documenting the implications of aesthetics on both the functionality and usability of products. Following in their path are researchers and designers examining the links between culture and aesthetics.

The importance of congruity between culture and the visual elements of artefacts such as websites has been noted quite early by researchers of website design (Barber & Badre, 1998; Luna, Peracchio, & de Juan, 2002; Marcus, 2002). Visual aesthetics correlates with usability (Altaboli & Lin, 2011; Sonderegger & Sauer, 2010). It impacts the overall design of, as well as people's responses to technology artefacts. Colour preferences, for example, show systematic patterns as a function of the three primary dimensions (i.e., hue, saturation and lightness) of colour, as well as show cross-cultural variance. The spatial properties and arrangement of the elements of a two-dimensional display influence people's aesthetic responses (Palmer, Schloss, & Sammartino, 2013). People from different cultures perceive visual design elements differently, and consequently often prefer different designs. Images that are acceptable in one culture might be considered insulting in another culture. Meanings associated with colours vary along cultural dimensions (Amant, 2005; Marcus, 2002). Value dimensions have been shown to correlate with user interface components such as colours, fonts, icons, metaphors, number of images and layout (De Angeli, 2009; Kondratova & Goldfarb, 2009; Marcus & Alexander, 2007), as well as physical attributes (Jhangiani & Smith-Jackson, 2007).

Comparative cultural studies show that some cultural factors related to aesthetic preferences seem to converge, but differences also manifest (Faiola et al., 2011; Mushtaha & De Troyer, 2007). Gender plays a role in aesthetic preferences. Women and men have different perceptions of needs and preferences relevant to aesthetic and functional elements of artefacts (Cui et al., 2007; Peranginangin et al., 2011). These findings suggest implications on design decisions regarding, for instance, the degree of complexity in interface layouts (e.g., the use of symmetry or asymmetry), the use of cool and warm colours, and the number and content of images used within the layout of a two-dimensional space, the shape and size of keyboards, etc. Still missing, however, is a better understanding of the relationships that link visual elements with cultural dimensions (Marcus & Alexander, 2007), and the problem is to identify some

measurable culturally influenced phenomenon that is linkable to visual aesthetics. Values, as previously mentioned, have been dominantly used in the methodology, but researchers have become increasingly aware of their limitations. Hence, efforts are being made to deploy other relevant constructs that could strengthen the cultural dimensions currently in use. Since preferences are partly driven by emotions, researchers have begun to examine the relationship of emotion with aesthetics applied to human-technology interaction design. In addition, the metaphorical function of emotion (Crawford, 2009), as well as of visual elements has been proposed as sub-area of research that requires more attention.

6.2.3.2 Emotions and aesthetics

Knowledge of emotional preferences is useful in design and could be used in designing visual elements and communications. Affect and emotion are universal and innate; however, their expression and appraisal vary from culture to culture (Ekman et al., 1987). Cultures differ in the kinds of feelings and words they use to describe emotions. And as presented earlier, sociocultural conventions can determine what arouses emotions. In Iran a woman not wearing a veil in public in conformity with purdah can cause anger, whereas in France a woman wearing a veil can cause the same emotional reaction. This type of correlation between sociocultural convention and emotional reaction has implication on aesthetics as well.

Emotions could be differentiated as two different types: utilitarian emotions and aesthetic emotions (Scherer, 2005). Utilitarian emotions allude to emotions such as anger, fear, joy, disgust, sadness, shame and guilt. These emotions can be considered utilitarian in the sense of their behavioural adaptive functions. They facilitate adaptation to events that have salient consequences for survival and well-being. In the case of aesthetic emotions, the utilitarian function is either absent or less pronounced. Scherer (2005, p. 706) defines aesthetic emotions as by-products of "…the appreciation of the intrinsic qualities of the beauties of nature, or the qualities of the work of art or an artistic performance. [S]uch aesthetic emotions are being moved or awed, being full of wonder, admiration, bliss, ecstasy, fascination, harmony, rapture, solemnity." Silvia and Brown extend this model of aesthetic emotions to constitute anger, disgust and negative aesthetic emotions in their analysis of people's responses to certain works of art (Silvia & Brown, 2007).

These proposed models of aesthetic emotions coupled with analysis of the cultural boundness of the appraisal process have implications for the design of human-technology interaction. While the models specifically address emotional response to art objects, they are also relevant to analyses of responses to technology artefacts. On the one hand, one could argue that aesthetic emotions are universal; on the other, the expression and appraisal of these emotions tend to vary from one culture to the next.

In the history of cross-cultural psychology, the study of emotions across cultures has spanned a wide range of topics and has made important contributions to its research, but application of emotion as a cultural construct to human-technology interaction research is at an early stage. Researchers have real-

ized the potentials of using emotion as a human-technology interaction construct, and are increasingly studying emotions across the aesthetic and cultural dimensions.

A methodological problem lies in how to measure emotion as a cultural construct. It has been proposed that using the constructs of personality traits and values (e.g., values model developed by Hofstede) could aid in the measurement. Yammiyavar (2005) suggests that understanding emotions on the cultural level could be used to understand the framework of the culture of a group, as well as to understand individual personality and to predict social behaviour of people belonging to the group. The underlying rationale states that although emotions are universal among humans, each person has a unique emotional profile. Since personality is a derivative of emotion, a personality type could be modelled if the emotional profile is known. By knowing the personality type, it should be possible to predict the culturally aligned emotional preferences.

In addition to personality traits, beliefs and values as cultural constructs could also be used in emotional profiles. Individuals and groups hold values. Values have been used to identify the basis of culture. A value has been defined as a preference for certain emotional states over others (Hofstede, 1980/2001). Hence, it should be possible to predict the value system of a group by measuring emotional states, and conversely with knowledge of a group's value system, it should be possible to predict the preferred emotional states of the group. An issue regarding usage of emotions as a construct in information and communication technology design research concerns their relationship to subconscious decisions and actions. It has been suggested that emotions could be considered as the go-between the human subconsciousness and consciousness. That is, emotions inform the conscious and the surrounding social context regarding solutions found in the higher dimensional space of the subconscious (Rauterberg, 2010).

Experiences of emotion are often described in metaphoric language. Some metaphoric representations subsume colour terms. Emotion and affective meanings of colour are known to vary across culture. Conceptualizations and linguistic expressions of emotion tend to vary from one culture to the next. Hence, one can infer that one must also examine variance in the aesthetics function of metaphors.

6.2.3.3 Metaphor and aesthetics

The application of metaphors in human-technology interaction design concerns several elements of artefacts, and is most obvious in user interfaces. The desktop metaphor, for example, is one used in computer interfaces, and it guides one's mental models regarding functions underlying the various visual and haptic elements found in contemporary computing devices. One uses electronic "wallets" and "money" for computer mediated commercial transactions, "emoticons" to stand for one's feelings, hand-swiping motions on screens to represent one's sense of direction, and so forth. However, culture-related usability problems have led to criticisms of currently used metaphors as well. And whilst the dominance of the desktop metaphor came as a result of several decades of de-

velopment iterations, in combination with the sheer lack of competing metaphors, efforts are being made to realign it culturally, as well as replace it with another that is more responsive to cultural differences (S. Shen et al., 2006). It has also been proposed that in addition to using metaphors to facilitate human-computer interaction, they could also support the design process itself (de Castro Salgado et al., 2011).

Metaphoric representation could be differentiated into two types: conceptual metaphors and linguistic metaphors. Lakoff and Johnson propose that conceptual metaphors are used to represent ideas in terms of people's conceptualization of concrete bodily experienced domains. There are some concepts that are learned through bodily experience and are understood directly. Spatial orientation and containment within space are examples of such concepts. Most other concepts, however, are more abstract. One apprehends them indirectly through repeated mapping of experience with concrete domains, and in terms of these original, or "source" domains. These representations are termed conceptual metaphors, and are distinguished from linguistic metaphors, which are used to express conceptual metaphors. People use conceptual metaphors to think about emotions. (Lakoff & Johnson, 1999).

Lakoff and Johnson's theory of metaphoric representation suggests that people use dimensional metaphors (e.g., spatial orientation, brightness) to map abstract concepts to common physical dimensions. For instance, concepts such as happiness, health, morality and status become coherent as they are mapped to the vertical dimension of space (Crawford, 2009; Meier, Hauser, Robinson, Friesen, & Schjeldahl, 2007; Meier et al., 2004; Meier & Robinson, 2004). Some affective metaphors use continuous dimensions as their source domain (e.g. "good is up"). Empirical work on metaphoric representation of affect provides evidence that the connections between target and source domains, as expressed in linguistic metaphors, also influence attention and evaluation (Meier & Robinson, 2004), and spatial memory (Crawford, Margolies, Drake, & Murphy, 2006).

Studies of how vertical spatial dimension is used to represent emotionally charged concepts also suggest a complex interconnection between emotion, metaphor, ethics and aesthetics. Meier and colleagues (Meier et al., 2007) observe that the major religions tend to hierarchically locate concepts of the divine (e.g., gods and heavens) above, and non-divine (e.g., hells and devils) below. They examined whether these associations affect performance on various cognitive tasks, and found that people implicitly associate the concepts god and devil with up/down terms; processing of god-related concepts is faster if they are presented in a metaphor congruent position (i.e., in a high vertical position); people's spatial memory of god- and devil-like images showed a bias toward metaphor congruence; and people rated strangers as more likely to believe in God when their images were located in a high vertical position.

While these empirical works focus on metaphors' function of enabling people to establish concrete coherence for abstract concepts such as emotion, they also point to metaphors' function as a reflection of ideal ethics and aesthetics values. And referring back to the discussion of aesthetic emotions, meta-

phors have both universal and culture-specific aesthetics and ethics dimensions. One could represent love as like a red rose, cleanliness as next to Godliness. Good guys always wear white hats, while bad guys wear black. These metaphors make sense at least in cultures that dominantly use the English language. They might not make any sense, however, in other cultural contexts.

As a cross-cultural category, aesthetics permeates the fibre of culture. It provides a tool for explicating cultural variance in cognition, emotion, and behaviour, and for describing how it is employed in interpretation of perception. Cultural variation in colour-coding, in colour's metaphoric function, in metaphors' aesthetic function, and in expressions of aesthetic emotion suggests a complex interplay between perception, emotion, and communication style as framed by ethics and aesthetics. Going back to W. Shen et al.'s (2000) critique of the use of semantic differential scales in kansei design, one has to consider whether the proposed universality of terms gathered through semantic differential technique is still open to debate.

Norman Kreitman argues that metaphor can be taken as a paradigm of poetry, in the sense that metaphor represents one of poetry's important constituents. Hence metaphor itself is a work of art. One reacts to a good metaphor with a response that can be described as aesthetic (Kreitman, 1999). This observation might be difficult to operationalize in the context of human-technology interaction design, but it behooves the human factor researcher to keep it in mind because it holds potentials for triggering aesthetic responses to designed solutions.

A standalone cultural theory of technology has weak applicability to the enterprise of design, and particularly to human-technology interaction design. In order to achieve a stronger application of culture to design, one has to link it to a design meta-paradigm, which is compatible in terms of flexibility and parsimony. It is suggested that the *life-based design* paradigm provides the necessary features for such a combination. Life-based design constitutes features that are necessary for a sufficiently holistic approach to human-technology interaction. "Sufficiently" in the present context means accurate and multi-dimensional enough for the endeavour in which one is engaged. The research strategy subsumed in this meta-paradigm is compatible with the research strategy constituted in the autopoietic cultural theory of technology: the use of form of life as a starting point and the examination the biological, psychological, and cultural dimensions of life.

6.3 Summary

The metaphoric representation of culture as a prism allows concrete coherence to the thesis that technology is a cultural phenomenon, a thesis that could be employed to guide the examination of universal and culture-specific human factor requirements to design of systems, and in particular the design of human-technology interaction. By refracting domains of action through the prism

of culture, one can systematically foreground the cultural factors affecting mental models, emotional and affective conceptualizations, and behavioural expressions of both creators and users of technology artefacts. The desire to create and use culturally aligned artefacts that contribute to well-being can be served by making both groups more aware of the many tacit culture-bound processes embedded in the design, engineering, and usage of technology.

The adoption of cultural materialist theory and research strategy, particularly its feature of assigning primacy to culture's infrastructure sector in causal explanations, into the proposed cultural theory of technology should serve as a reminder that culture's symbolic-ideational sector might not be the sole source of causal explanation for variance in a given design attribute. While several approaches to human-technology interaction design such as kansei design, ethical design, and design for pleasure have all made important contribution to understanding human factor requirements, works by researchers in cross-cultural technology usage (e.g., Irani et al. 2010; Rangaswamy & Singh, 2009; Winschiers-Theophilus, 2009) point to the inadequacy of these approaches to capture factors situated in the infrastructural (i.e., production, reproduction) and structural (i.e., domestic and political socio-economy) sectors of culture, factors that are even more salient to the requirements of people living outside the Western and industrially advanced contexts.

The concept of co-culture serves as a reminder that variations in design relevant biopsychological, ethics, and aesthetics attributes occur at both the inter- and intra-cultural contexts. For instance, people from a culture of disability, or from a culture of aging conceptualize and live their daily life differently relative to other groups situated within national as well as international borders. As pointed out earlier in relation to using national identity as proxy for culture in research methodology, measurements of cognitive and affective indices must factor in the presence of co-cultures.

With the proliferation of systems for non-experts designed with self-explanatory or "intuitive" user interfaces (in contrast, to systems that require intensive training for users), consequent problems resulting from technology/culture misalignment are coming more to the forefront of people's daily life. One can argue that the problem also includes systems designed for experts (Häkkinen, 2010). An implicit but large part of this problem is that much of contemporary technologies are designed and engineered in Western and industrialized regions still mostly dominated by the U.S., Northern European countries, Japan and Korea. While for the most part cultural assumptions regarding human factor requirements that get embedded into a given technology are consistent with the dominant culture within the borders of the source of the design and engineering, these embedded factors often clash with the equally implicit cultural conditioning of perception, cognition, emotion, ethics, and aesthetics when the artefacts are transferred beyond the source region. Hence it behooves the researcher to employ culture as a point of convergence to help mitigate the problems of culture/technology misalignment.

Explicating the effects of culture on largely unconscious ideational and behavioural processes is a daunting task when one considers the complex interplay between the design-relevant attributes. While a description of the attributes as discrete components allows for a manageable process of analysis, one should nevertheless foreground the interconnections between the attributes. That is, one must holistically view them, whether one uses the prism of culture as part of usability studies, or of the design process for engineering a completely novel technology. Data collection on people's needs as mediated by sociocultural and biopsychological factors has obvious application for existing approaches to human-technology interaction design, particularly in user usability and user experience focused approaches. Conceptualizing novel technology supporting people's forms of life necessitates a holistic design strategy such as life-based design. The proposed culturally responsive human-technology interaction research strategy could extend life-based design's power to capture the cardinal design-relevant attributes from forms of life.

7 TECHNOLOGY IN LIFE: LIFE-BASED DESIGN

> "The function of man is a certain form of life, namely an activity of the soul exercised in combination with a rational principle or reasonable ground of action" (Aristóteles as cited by Thompson, 1963, pp. 38-39).

The present work has argued for a movement toward culturally responsive human-technology interaction design frameworks, supported by a review of the state of the art frameworks available today to human-technology interaction research and design practitioners. In is now time to set up the practical application of the prism model of culture to the design process.

To extend the use of cultural dimensions to an existing framework, the cultural materialistic notion of culture is situated as the pivot construct in an integrative approach to design, namely the life-based design strategy. The issue at hand is to get an integrated view of a domain of action, and to increase one's understanding of the relevant biopsychological- and sociocultural-determined needs in order to identify the opportunities for fulfilling them, as well as to describe the constraints, i.e., biopsychological and sociocultural, that stifle the ability to reach the desired goals. Life-based design provides a meta-paradigm and practical approach for anchoring the design of human-technology interaction to the analysis of human life. In the context of the present work, the approach aims at clarifying the design process for information and communication technology artefacts, but it can be deployed in designing any artefact. Life-based design employs the construct *form of life* as the basic concept in analysing the relations of everyday life and technology. A *culturally responsive life-based design* makes explicit differences and similarities in cultural mediation or moderation of the factors.

As with many design research projects, one is faced with the basic problem of eliciting knowledge from people about how they represent the current state of their subjective world. For instance, most people are not able to articulate their need to simplify certain tasks that they consider complex, or whether they would have a strong opinion that a certain daily task should be considered complex at all. Most will have difficulties articulating whether their rule following actions would require technological assistance because most of these actions are probably part of their *proceduralized knowledge* (see Barsalou, 1992, p. 150)

that are in general difficult to describe and report. In designing artefacts for people, one will have to figure out what would be the attributes relevant to the artefact. This will be difficult if the artefact does not exist yet. Hence in the early stage of the design process, one has to systematically cycle through several processes. There is a proposed methodological framework constituted in the life-based design paradigm, and the relevant practical steps had been organised in four stages: form of life analysis, requirements and concept design, fit for life design, and innovation design (Leikas, Saariluoma, Heinilä, & Ylikauppila, 2013, pp. 125-131). This framework provides a guide to extracting a more granular view of relevant human factors.

7.1 Cultural extensions to life-based design methodology

The present work proposes extensions to life-based design in order to assist in foregrounding cultural factors relevant to the research and design processes. As previously stated, this proposal entails using culture as a pivot construct. The assumption is that people possessing multiple levels of culture, whether the design project attempts to create artefacts for a specific geographical region or to multiple regions, will utilize the artefact. Hence at minimum this means the human-technology interaction practitioner should examine the form of life and related domains of action through the prism of culture in order to extract data on (1) cultural similarities and differences in biopsychological, ethical and aesthetics needs/desires; (2) environmental, biopsychological and physical, and sociocultural affordances and constraints; (3) relevant values and values prioritization. Table summarizes the mapping of the extensions to life-based design methodology.

TABLE 10 Extensions to life-based design methodology.[42]

Life-based design phases and prism of culture extensions	
I. Form of life analysis	**Extensions**
Analysis of form of life	Culture-bound biopsychological, ethical and aesthetics needs/desires; environmental, biopsychological and physical, and sociocultural affordances and constraints; relevant values and values prioritization.
Design goals definition	Cultural alignment
Role/function analysis of legacy technology	Culture-related modifications to technology, culture-specific affordances and constraints from technology.
Design relevant problems explication	Environmental, biopsychological and physical, and sociocultural constraints.
Typical actors	Gender, age, abilities, socioeconomic class.
Typical contexts	Domains of actions
Design theme and human requirements	Cultural alignment

TABLE 10 continues.

42 Adapted from Leikas et al., 2013.

TABLE 10 continued.

II. Requirements/Concept design	**Extensions**
Role of new technology	Cultural alignment
Conceptualization of solution	Analysis of cultural similarities and differences in biopsychological, ethical and aesthetic attributes.
User interface design	Inputs from analysis of cultural similarities and differences in biopsychological, ethical and aesthetic attributes.
User evaluations	
Technical design and implementation	
III. Fit for life design	**Extensions**
Explication of logic behind life quality enhancement	Inputs from analysis of cultural similarities and differences in biopsychological, ethical and aesthetic attributes.
Evaluations (fit to form of life and ethics)	Criteria: culture-bound biopsychological, ethical and aesthetics needs/desires; environmental, biopsychological and physical, and sociocultural affordances and constraints; relevant values and values prioritization.
IV. Innovation design	**Extensions**
Usage culture development	Inputs from analysis of culture-bound biopsychological, ethical and aesthetics needs/desires; environmental, biopsychological and physical, and sociocultural affordances and constraints; relevant values and values prioritization.
Infrastructure definition	
Marketing plan	
Service and auxiliary (e.g. maintenance) activity definition	
Illustration of technology life cycle	

The potentially problematic nature of using the form of life construct, and by extension its rule-following action component was pointed out earlier. A view of form of life states that it encompasses the various cultures and subcultures that individuals participate in, the meanings and objective conditions shared by these cultures, as well as the way of experiencing life and the mode of actions (Leikas, 2009, p. 90). Hence the form of life construct presumes the influence of culture on human-technology interaction. It remains ambiguous, however, as to how culture affects its biopsychological components. In order to disambiguate these relationships, one has to make explicit both the universal and culture-specific characteristics of the components. Otherwise it is difficult to identify design-relevant attributes that are inter- and intra-culturally responsive. Without the foregrounding analysis, one is left to assume that the human factor requirements, which one identifies are already culturally aligned since the form of life framework implicitly subsumes culture. By using culture as the prism through which the domains of action are viewed, one can make explicit the cultural-boundness as well as universality of given rule-following actions, mental models of biopsychological factors, social capacity, norms, values, and attitudes.

7.1.1 Rule-breaking action

Forms of life differ according to combinations of factors such as age, social status, family status, health, profession, education, skills and gender. The facts and values of these factors are conceptualized differently across cultures. In addition to studying rule-following actions, it is equally important to identify contraindicative activities, which one could call *rule-breaking actions*. As Marvin Harris pointed out, in sociocultural life, every rule is surrounded by rules for breaking rules, which themselves have rules for breaking rules ad infinitum (M. Harris, 1999, p. 23).

Why is it necessary to study both rule following and rule breaking actions? Usage of technology is related to biases in cultural transmission. Rule following actions are manifestations of people's tendency to imitate the majority—that is, conformity. Rule-breaking actions constitute nonconformity. People sometimes copy cultural forms because they are rare. The interplay between people's conformist and nonconformist behaviour allows innovation to initially spread because of its novelty and continue to spread because of its frequency. This process can be observed in people's use of clothing fashion. New fashions such as street clothing of a subculture, or innovations by a small group of fashion designers can spread first because of their novelty then spread through conformity.

One must also consider the contradictions that manifest when large numbers of people simultaneously attempt to conform to certain social norms. For example in Finland, the high load of data traffic on the mobile communications network, akin to car traffic jams, during the final moments of New Year's Eve as people send each other text messages is an example of unintended behavioural consequences of aggregate conformity to rules. The implicit rules applying to mobile text messaging are concerned with instant delivery of the message to its destination; there are no rules specifically concerned with guiding the message traffic into a condition similar to gridlock[43]. Designers must also examine higher-order systemic processes (i.e., processes moderated by economic and ecological factors), to test for causality based on theories using infrastructural variance.

7.1.2 Emic and etic descriptions

Regarding the use of both emic and etic descriptions in the research strategy: one cannot rely solely on emic descriptions of mental life for prediction or retrodiction of behaviour. Emic descriptions are always subject to a redesign post facto. That is, people also have the proclivity to change their own descriptions of their mental life to fit their observed behaviour. In fact emic descriptions are "*indispensible* [emphasis in the original] to allow for the human capacity to lie, obfuscate, forget and disguise inner lives; to say one thing and do another; and to produce in the aggregate effects that were not intended by any participant" (M. Harris, 1999, p. 42).

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[43] See e.g., "aggregate conformity to rules" in M. Harris, 1999, p. 24.

Purely emic accounts will not be sufficient for prediction or retrodiction of both intentional and unintentional consequences of technology. For example, most of the emic accounts aggregated in results of surveys of people's use of the Internet identify the most popular usage as communication among friends, colleagues, and families through email, and other communication software (Stryszowski, 2012). But this emic data cannot be used to explain the etic behaviour that identifies access to pornographic websites as the top source of revenue for their providers (e.g., Davenport, 2001); this etic description depends on data on aggregate global revenues earned from various products and services accessible through the Internet.

Prediction or retrodiction of breakdowns or unintentional consequences of technology usage such as for instance "flaming" (Suh & Wagner, 2013), the term given to highly acerbic comments by anonymous participants aimed at other individual or group in the context of conversational forums or newsgroups during the 1980s, would be close to impossible through emic descriptions of the mental state of the participants. Early participants stated intentions for communal sharing of information. An examination of related behaviour of anonymous participants to new media's efforts (e.g., wikileaks) to uncover misconduct among people in power positions could be a better source for an etic description (Beyer, 2013; Hindman & Thomas, 2013). People who provide information that could prove damaging to the reputation of politicians to journalists on the condition of anonymity could provide legitimate information. On the other hand anonymous "tipsters" could also provide completely false information. The point is that journalist and news organization have a very difficult time checking the legitimacy of the given information. It took years of efforts to publish rules of etiquettes to control flaming before designers of some Internet communication media simply did not allow anonymous comments.

With regard to designing computer-based communication technology, Winograd and Flores (1986, p. 158) argue against the possibility of completely avoiding breakdowns because during the design process, one has to select a finite set of anticipations from the situation. One, however, can partially anticipate situations where breakdowns are likely to occur by noting their recurrence, and thus provide people with tools and procedures for coping with them.

In relation to life-based design, emic descriptions of rule-following actions are important in making explicit a list of actions that could be supported by technology. From the design perspective this process is akin to designing a better mousetrap. But the probability of finding truly novel application of technology in people's life could be higher in the etic observations of rule-breaking actions. One should determine the culturally loaded constraints that trigger a desire for a designed (technology-supported) solution. Emic descriptions in turn can help uncover similarities cross-culturally.

Situating the cultural materialism construct into the design strategy allows designers to synthesize a culturally responsive life-based design approach that explicitly seeks to (a) align a technology artefact's physical and symbolic functions with the biopsychological and sociocultural determinants of the domain of

action, (b) predict breakdowns and changes in the other sectors of the cultural system in situations of group conflicts, and (c) recover from breakdowns. Although the proposed approach mainly concentrates on gathering data as input for the early stage of the design process, there is impetus for using a culturally responsive life-based design in the re-design of technology artefacts: the design strategy can help identify the false understandings (and the actions based on them) that were embedded in the previous design, and thus provide a path toward cultural fit in the re-designed artefact.

7.1.3 Illustrative application to theoretical and empirical work

A theoretical work by Jaana Leikas and colleagues exemplifies the application of life-based design to the design and development of services that can be deployed in the Internet. The researchers identified loneliness, defined as social isolation, amongst older adults as a life situation for which intervention practices could be designed by using the life-based design strategy. They used the notion of a situation in life as the pivot concept through which they examined the various facts of a form of life (i.e., life as an elderly person). They argued that situations in life determine the characteristics of life, and also aid in comprehending the everyday context of people's life (Leikas, Saariluoma, Rousi, Kuisma, & Vilpponen, 2012).

Using situations in life as a pivot construct, however, does not preclude the use of values or domains of action as a starting point for the design process. Regardless of the pivot concept, the process necessarily includes an examination of values and actions to define relevant design attributes as well as define actions that can be supported with technology. After identifying, defining, and analysing the properties of social isolation amongst elderly people, the researchers continued with the life-based design procedures by differentiating the types of isolation according to its cause (i.e., social, individual or contextual), conceptualizing technical means for avoiding or decreasing the problems, and creating a usage culture among the people who would require the technology.

As previously stated, a culturally responsive human-technology interaction design explicates the similarities and differences in the cultural mediation or moderation of the phenomenon under study. Hence, a study of loneliness should include an examination of the effects of culture on the meaning of loneliness as well as an analysis of how people cope with social isolation in old age in different cultures (e.g., Rokach, Orzeck, & Neto, 2004). The value of information regarding the cultural dimension is obvious in designing services that will be deployed through the Internet; however, it is equally important for services that are situated in a single country (e.g., Saariluoma et al., 2013).

Perhaps the discipline of gerontechnology viewed from the frame of form of life exemplifies the difficulty and complexity of what can be justly called the remit of cultural cognitive science in analysing human factor requirements that can be used for designing and engineering systems truly responsive to various forms of life.

Behavioural and cognitive neuroscience studies to date suggest that many cognitive processes similarly decline across cultures, thereby supporting the theory of universality of cognitive aging. On the other hand, it seems that culture can exert a controlling influence on neurocognitive aging, particular in regard to the development of knowledge structures (D. Park & Gutchess, 2006; D. C. Park, Nisbett, & Hedden, 1999).

The implications from these studies should be clear to researchers interested in supporting creation of culturally responsive technology artefacts: one cannot assume invariant the design-relevant human factors, either inter- or intra-culturally. Even when one conceptualizes technological designs for a single culture, the cognitive, emotional, and behavioural needs of co-cultures—that is, cultures of youth, aging, disability, gender, etc.—must be taken into consideration. A closer look at the constraints manifesting in a domain of action could open up possibilities for innovative designed solutions to creating new forms of life and domains of action, as well as innovating new supporting technologies. Refracting domains of action through the lens of culture enables more nuanced insights that should further assist in creating culturally responsive artefacts, which consequently contribute to enhancing well-being and human life.

8 CONCLUSION: TECHNOLOGY OF BEING HUMAN

Proposing a cultural theory of technology is to a degree an exercise in stating the obvious. Two decades of published works in the field of human-technology interaction offer what can be considered self-criticism of the field's paucity in including cultural factors to its processes. It seems counterintuitive to propose a theory of technology that subsumes it into culture, for such a proposal seems to go against the pundits' narrative about the universal effects of information and communication technology, and about the independent status of technology as an agent of change in contemporary human existence. Those born in the early part of the twentieth century could probably attest to various changes in society brought about by technological innovations, and those born during the latter part have already been witnesses to relatively rapid changes through advances in computer technology and various technologies supported by ICT. The threads of contemporary human life seem to be tightly woven with those of culture and technology.

8.1 Facing the problem

It is within the context of the human need for well-being that the problem addressed by the work at hand derives its salience both for society at large as well as for human-technology interaction practitioners. The major symptom addressed by the present work is the mismatch between people and technology artefacts. This symptom is not caused by any deliberate effort of experts bent on making people's life difficult. On the contrary, researchers, designers, and engineers responsible for creating new products generally endeavour to improve people's lives. Many observers whose works have been reviewed in the present work have pointed to one of the primary causes of the symptom: a continuing clash of cultures. There is the clash between the culture of experts who create technology, and the culture of non-experts who use technology; between the cultures of young and older users of technology; between cultures situated at

opposite sides of the so-called digital divide; between dominant and co-cultures within national and supranational borders; and between cultures of people who emphasize global versus local community participation.

At times awareness of the symptom caused by these culture-clashes surfaces through anecdotes that are meant to be humorous. The present work contends that neither the symptom nor its end result are humorous, for some of the results have been fatal to human life, as for example in the case of airline crashes whose root cause is partly attributable to ethnocentric assumptions reified in warning system's user interfaces (e.g., Häkkinen, 2010, pp. 80-81). From the perspective of the human-technology interaction experts and technologists in general, it should be obvious that addressing the problem of mismatch between people and products means concurrently addressing the fundamental question of whether it would be better to cure the symptoms or to find remedies for the primary causes. The present work argues for the latter approach.

8.2 Path to understanding

Why does one need to go through this process? It has been argued that from the perspective of users of technology in daily life, artefacts are often misaligned with their ways of thinking, feeling, and behaving in the world; that technology is often misaligned with people's culture. In essence, usage of technology is fundamentally linked to the human drive for well-being. From the perspective of creators of technology, there is the challenge of making artefacts that are easy to understand and use, and that truly help people in their daily life. There is professionally and economically motivated interest in matching products with people's need for well-being, and successfully ensuring appropriate alignment between people and products has important implications to the continuing development of the human-technology interaction research and design disciplines. Ensuring appropriate alignment necessitates a holistic understanding of both the symptom and its causes.

It has been explained in chapter 1 that root causes contributing to the primary problem of misalignment, from the HTI research and design perspective, are the following: (1) Systems design and engineering processes are realized with assumptions that are ethnocentric; that is, the narratives embedded in the processes employ concepts that are implicitly assumed universal across cultures. Embedded concepts, based on Western epistemology and ontology, are particularly difficult to make explicit. As a group, human factors experts, designers, and engineers constitute a culture that articulates distinctive norms, values, and attitudes regarding technology. Without systematic processes to foreground technology's ethnocentric embeddedness, the culture of the experts becomes the norm for both the source and target domains in analysing human requirements. (2) There is a tendency to over-emphasize usability issues. The emphasis on usability is understandable given the current challenges brought on by mismatches between people and existing products. This tendency however also tends to

underemphasize the need for a more nuanced understanding of the root causes and their relation to people's forms of life and domains of action. (3) Current research approaches are divergent, and it is difficult for human-technology interaction researchers to develop cumulative knowledge applicable to a variety of projects. (4) Paucity in theory and hypotheses development is a hurdle along the path to convergence in the field of human-technology interaction research and design. The present work aims to remedy the fourth root cause with a proposal for a theoretical model, which could support a culturally responsive research and design strategy.

It is incumbent upon organizations, particularly business enterprises, responsible for creating technology products to integrate what one can call "culturally responsive R&D" into their processes. From a business perspective, it is suggested that one should consider that skipping a culturally responsive R&D process can cost a business: one might build irrelevant features that increase cost and complexity to the product or service; one's customers may not understand or under-utilize the service, or they may neither perceive nor receive the service's total value.

From the perspective of preventing problems in product usability related to cultural contexts, it is important to recognize early in the design process that designers also have unconscious cultural biases, which often get embedded in artefacts. And when people of different cultures encounter the artefact, they will likely misunderstand the meaning that the designers attempt to communicate by design. As Kam, Mathur, Kumar and Canny (2009, p. 39) concluded in their post-project analysis of learning videogames for rural children in India, "[W]e found that situating game settings in everyday scenarios is necessary but insufficient… We now realize that our prior experience with Western style games have led to these cultural expectations creeping into our processes and design outcomes…." Such a realization serves as a reminder that one needs to examine the relationship between culture and technology.

Why is it important to understand the relationship between culture and technology? On the mundane level, and for the most part the level on which development of technology has focused on, culture and technology provides viable strategies and practices that enable people's life experiences to be aligned with their perceptions of well-being (Leidner & Kayworth, 2006; Leikas, 2009). In effect, this is one of the primary premises of theories for human-technology interaction. A good enough alignment of technology, practices (both behavioural and cognitive), language and cultural characteristics contributes to people's daily well-being.

If techno-cultural alignment is important at the individual level, it follows that such viable, good-enough alignment is at the core of the continuing evolution of human cultures, and the continuation of human forms of life. From the perspective of design, it should be clear from the previous discussion of the mutual specification of culture and technology, as well as morality and culture, that there could not be such a thing as a culture- or value-free design. This is something that creators of artefacts, whether one calls them architects, artisans

or artists, have implicitly known for millennia. Prehistoric architects certainly had intimate knowledge of the material conditions in their given environment, and this tacit, perhaps even mystic, knowledge has been embodied in the artefacts that they designed and created. A deep fine-grained understanding of the dynamics between forms of life, the various levels of culture and innovative technology would help clear the path to convergence in the field of human-technology interaction research and design, and consequently aid in ensuring delivery of products that are well matched with people's need for well-being.

8.3 Intervention at the level of root cause

The present work has attempted to articulate a theoretical understanding of the relationships between human life, culture and technology. It asserts culture's primacy within the context of a co-deterministic relation to technology, with the motivation of sensitizing both expert and non-expert observers of human-technology interaction to the continuously evolving need for alignment between human requirements and technology design. Most relevant to the practice of human-technology interaction research and design is the identification of multi-level cultural conflict as one of the root causes of misalignment between people and products. Hence the proposed solution implies intervention at the root cause by attacking one of its sub-roots: paucity in theory development.

The proposed prism of culture model assumes improvement of people's life as the primary role of technology in people's daily life and life cycle. Therefore the theoretical model aims at foregrounding biopsychological, ethical, and aesthetically grounded values, norms, attitudes, beliefs, practices and rituals relevant to extracting a deep understanding of the relations between the life-culture-technology triad as they manifest within people's forms of life and domains of action, and knowledge, which is necessary for extracting data relevant to each stage of a holistic design strategy and method (e.g., life-based design).

8.4 Complexity in life-culture-technology systems

The issue with universal versus cultural relativity could be reframed as a problem of finding design-relevant processes that are universal to all humans but are also modulated by culture. To this end the proposed theoretical model of a cultural human-technology interaction can be focused on the universal biopsychological processes of perception, cognition, and emotion, and the variance in the patterning of their appraisal through the frames of ethics and aesthetics. In other words, while attention remains with universals, one nevertheless has to foreground the variations in interpreting the significance of human interaction with technology. Cultural variance in the patterning of the appraisal process can be viewed as a reaction to the inherent ambiguity in the relationship be-

tween the form and function of artefacts interposing between humans and nature. Acknowledging this ambiguity helps in understanding the possibilities for variations in the meaning of technology. This process requires an interdisciplinary approach, and in this sense the field of cognitive science provides an appropriate foundation. In the case of the present work, inspiration and support for theoretical development were derived from cultural materialism theory from anthropology, general systems theory, embodied cognition theory, and cultural psychology.

One could say that the biggest challenge for those who study the relation between life, culture and technology lies in how one could focus less on producing more findings about cultural differences, and to think more about ways of integrating the findings into comprehensive, cohesive theories. This integration requires an interdisciplinary approach. Such integration could provide parsimonious theories that would guide the enterprise of human-technology interaction research and design.

The shortage of integrative theories and the limitations in applying cognitivist theories to the human-technology interaction domain, as identified in literature reviews presented in this work, have motivated the author to use the materialist view and materialist-based research strategy. This work contends that this approach provides a more holistic source of causal descriptions and explanations of the circular co-determined relationships between culture and technology. Cognitivist-idealist theories—e.g. mental models and ethnoscience, which are implicit in the majority of empirical examples presented in this work are in principle useful to describing the effects of material conditions. However, these theories seem to either deny or ignore ecological and material factors, which have been recently emphasized by researchers working in the domains of post-colonial computing, ICT for development, and digital divide. An understanding of these factors are also necessary for understanding the cultural nature of technology.

Culture is not the only factor that affects human requirements for technology, but it is perhaps the most difficult to explicate largely due to its tacit, and dynamic dimensions. Material conditions have impact on culture's characteristics. Hence an analysis of material conditions must be included in the foregrounding process. But while material conditions might have primacy as a source of explanations for cultural variance, people employ ideologically founded appraisal of the significance of the impacts, particularly of the power dynamics between members of cultures, who in turn can influence material conditions in societies. A materialist theory-based prism of culture model is analogous to using a multi-focal lens to view and analyze a phenomenon of interest. However, this approach does not exclude the possibilities of using a single-focal lens to view some of the details.

Culture's tacit trait impacts the human elaboration of space, expression and appraisal of emotion, preference for a certain way of learning, and preference for a certain way to solve problems in daily existence. But both the impacts and consequent behaviour remain beyond normal daily consciousness. One

goes through daily routines without much thought to the interplay between culture and technology, and perhaps one becomes more conscious of it only during encounters with mishaps or breakdowns in life's routines supported by technology.

Prior to the contemporary usage of the term "designer", makers of material artefacts, that is, the artisans, had intimate knowledge of the local environment and the culture in which their designs are situated (Lawson, 1997). However, since knowledge of culture is tacit knowledge, it is plausible that these artisans did not explicitly articulate cultural concerns that might or might not affect any given artefact, and the human actions with it. Artefacts either served or did not serve their expected purpose. It follows that artisans heuristically made modifications accordingly, depending on the perceived results. Recent empirical studies on the relationship of culture and technology design imply that a similar situation exists in the field of contemporary design (e.g., Norman, 2002). Cultural factors remain in the background and are generally ignored or forgotten. Why should it make any difference whether a designer explicates culture's characteristics in his or her design process? This work argues that a culturally responsive design process will systematically produce technology solutions that are well aligned with people's desire for well-being.

It might seem that undue weight is being placed on the designer's shoulders to take the responsibility of making culture-relevant technology artefacts. This is true from the view that creators of artefacts have much more practical control of the creative process. However, whether they are conscious of it or not, the users of technological solutions also exert much influence on the design process. People can use or refuse to use or even modify a designed solution. These events, culturally bound, are important sources of knowledge for designers. Therefore foregrounding the techno-cultural dynamics is indispensable to understanding their effects on design.

From the user's perspective, a similar process would be difficult to realize without the designer's intervention, for example by communicating through documentation or through the user interface. Regardless of the intervention chosen, people do not have to be exposed to the technical complexities of technology solutions to daily life. They intuitively employ tacit knowledge, that is, cultural knowledge, in their interactions through technology. Thus a process of making explicit the techno-cultural dynamics embodied in an artefact remains largely undone. While the brunt of understanding the techno-cultural dynamics is indeed on the designer, individuals cannot escape the obligation to be aware, particularly in situations involving issues of power.

Humans design technology in response to natural constraints on human experience, but they also use technology to establish sociocultural constraints to their own actions as well as in their intra- and inter-group interactions. Examples of mundane self-imposed constraints with the support of technology include weight-loss diets, waking up with an alarm clock, and contraception. One could argue that technologies have emergent applications either towards overcoming constraints or supporting them. For example, mass media practices and

technologies allow people to experience within the comfort of their living room the thrills or agonies of a fellow human-being situated at another space and time. The same practices and technologies enable intentional manipulation of human thoughts.

Contemporary urban planning supports people's needs for congruence in their life. It also supports segregation policies, or some other policy that is questionable from the perspective of well-being. Consider the trams or streetcars, which one rides in many major metropolitan areas of the world. From the ecological view, this railroad technology is an important component of the technology solution to the desire to move masses of people within cities. Yet it has been employed to reify the constructs "whiteness" and "blackness" and to redefine the domination of European Americans over African Americans in nineteenth- and twentieth-century United States (Zylstra, 2011).

One could further argue that domination through technology continues in much of the world. Hence certain technologies could come to symbolize social dynamics within groups as well as across groups. Intra- and inter-group struggles for domination of infrastructural resources such as food, shelter and medical care invariably manifest at the symbolic level of sociocultural systems. Likewise with the contention for domination of superstructure resources such as the Internet, one encounters contention in so-called digital divide issues. Designers and builders of technology should include issues surrounding the digital divide into the ideological and power relations discussions in order to avoid perpetuating and contributing to the gap between participants along the racial and ethnic lines. Hargittai and Hinnant's (2008) findings from a study of Social Network Services usage among university students with diverse demographic characteristics suggest that the choice to use different participatory media is based on racial and ethnic background, as well as parental level of education. This fact in turn suggests that there is less intermingling of participants from different backgrounds. This finding is contrary to the narrative about the supposed democratizing function and freedom of online interactions (e.g. Levy, 1997). The membership of certain online communities reflects people's social networks in their everyday lives.

Understanding the relationship between culture and technology makes intelligible certain inequalities that people experience in everyday life. This understanding is indispensable in deciding for one's self whether a technology is essential to one's survival and well-being, whether it is being used to maintain inequities in access to strategic resources, or whether it is being used as a means of control. Familiar and perhaps even cherished cultural practices and technologies have a history, and they often involve power struggles and questionable motivations (Prinz, 2007).

An understanding of even the mundane impacts of culture and technology could lead to an important component in the "invention" of new viable strategies that are appropriate to various cultures and forms of life. More importantly for the context of everyday experience, culture as a construct of self-knowledge and of others serves as a foundation for negotiating roles and possi-

bilities for actions as agents in sociocultural systems. Clearly, this knowledge will not have immediate impact for some people nor will it have equal effects for everybody, due to the great variations in life situations.

There is no doubt humans have also used knowledge of cultural differences, or more precisely the framing of culture through constructs such as ethnicity, national identify, or sociobiological and biological determinism, for example the notion of Intelligence Quotient as genetically determined (e.g. Herrnstein & Murray, 1995 cited in M. Harris, 1999), to justify negative actions such as aggression by one group toward another, or subordination of one group by another through maintenance of hierarchical inequities. This tendency has more to do with the abilities of certain groups to employ socio-political power to further their own interests in power inequities and unequal access to strategic resources. This situation, however, must serve as a reminder: self-knowledge and knowledge of others, including an explicit consciousness of culture, are not merely matters of theory. They have very practical impacts on everyday life.

Modern historians and philosophers (e.g. Kuhn, 1996; Laudan, 1977) argue that the scientific enterprise mutates radically from one epoch to another, and that the history of science does not follow a linear progression. The current state of human-technology interaction research and design through its connection with cognitive science might be a distinct mutation: it has inextricably linked knowledge to a technology, which transforms the social practices that makes that very knowledge possible. This is in reference to digital computer technology, and particularly its application to artificial intelligence.

For millennia, people have had a spontaneous understanding of their experiences, and this understanding is framed by the context of time, life, culture, and technology. Through technology, this folk understanding has become linked to science and can be transformed by scientific constructs. It is suggested that just as one cannot separate life, culture, and technology, nor cognitive science and human-technology interaction studies, neither can one have a well-rounded human-technology interaction research and design discipline without the scientific pursuit of culture. The scientific study of culture cannot be separated from cognitive science because the cognitive scientist's reflection is an act performed out of the background (in the Heideggerian sense) of biological, social and cultural beliefs and practices (Varela et al., 1991/1993, p. 6). Science is a distinctive form of ideology. It is culturally embedded and culturally constructed.

8.5 Future work

People's usage of technology has not really made the world "flat" again. Technology has enabled people to transcend constraints. By employing metaphors such as "environment", "desktop", "web", etc., creators of technology artefacts have attempted to frame human behaviour with concepts familiar in daily existence in the material world. Hence one finds it plausible that the world has

indeed become flat. Technology has enabled people to construct new forms of life, new cultures, and new cultural constructs might be replacing those that one has grown up with. There are some indications that a planetary culture based on concepts of collective participation might be evolving, largely mediated by information and communication technology through the Internet infrastructure. One must question, however, whether the descriptions of this phenomenon come with unexamined assumptions embedded in them. The idea that information and communication technology has contributed to the globalisation process makes sense. The effects of globalisation on human life, however, seem to be much more complex; it has homogenised some aspects of everyday life, polarized others, and encouraged cultural hybridization (Holton, 2000).

The complexity of the continuously evolving dynamics between nature and human life and culture, and between culture and technology suggests that one cannot remain at the theoretical level. At present, there is already ample impetus based on realizations from the sub-disciplines of usability and user experience to deploy a culturally responsive research strategy and design process. The proposed theoretical model should be of utility to current practices. But to continue moving the field of HTI toward convergence, it is the contention of the present work that gaining knowledge and training on cultural models should begin early in the education and training of HTI practitioners. Several new issues that require attention and research have already appeared on the horizon. These issues include the homogenisation, or shrinking of cross-cultural differences; the globalisation of hybrid cultures; Internet as a symbolic culture; and the role of electronic acculturation in people's lives.

The true test of the proposed theoretical model's viability begins with empirical validation. Thus future work necessarily includes validation of the theoretical model. It is suggested that validation could be conducted through applied research in gerontechnology, augmented/mixed/virtual reality environments, persuasive technology, learning technology, the Internet of things, and big data mining, because these fields carry potentials for near-term (i.e., within 10 years) impacts on people's life as viewed from the group to the supranational levels of culture.

In one way we are alike, in another way we are somewhat alike, and in yet another way we are like no other (C. Kluckhohn & Murray, 1950, p. 35). Issues related to the diverse needs for technology in the daily life of culturally diverse individuals are not hypothetical questions. Examples of contemporary technology usage in India (e.g., shared mobile phones) and in Africa (using mobile phones to pay for electric service in rural areas) suggest selections for technologies that address issues of systemic inequities. A culturally responsive human-technology interaction research and design strategy should assist in catching a glimpse of this type of latent need.

The present work suggests that it is through examination of people's forms of life that one could begin to better understand the relations between human life, culture, and technology. Like other higher primates, humans created cultures as a by-product of continuous interaction with the environment.

They developed tools to support their interaction. Through the evolution of humankind, life, culture and technology have become intertwined to the extent that technology and technological change have become vital to the evolution of human forms of life and culture. Life is culture. Culture is life. Culture is technology. Technology is culture. They have become interwoven in the history of human experience. They provide strategies and practices for well-being, for a better life, for being human.

YHTEENVETO (FINNISH SUMMARY)

Teknologia on tullut ihmisten arkipäivän elämässä yhä huomaamattomammaksi ja sen hyötyjä pidetään itsestään selvinä, ainakin siihen saakka kunnes tuotteessa ilmestyy jokin vikatilanne. Tällöin tiedostetaan, että tuote ei vastaakaan tarpeita eikä odotuksia. Se ei olekaan yhteensopiva sen tiedon kanssa, kuinka asioiden tulisi toimia. On havaittu, että kulttuuriin liittyvät tekijät vaikuttavat teknologian käyttöön. Ihmisillä on erilaisia ajatusmaailmoja, tapoja ja käyttäytymistä, eli kulttuuri ulottuu odotuksiin tekniikkaa kohtaan. Nämä tekijät ovat usein arkipäivän tietoisuuden ulkopuolella. Tutkijoiden ja tuotesuunnittelijoiden näkökulmasta on tärkeää kohdistaa tuotteiden ominaisuudet ihmisten tarpeisiin, mutta on myös oleellista huomioida ne hiljaiset tiedot, jotka perustuvat kulttuurisiin tekijöihin. Olemassa olevien teoreettisten mallien vähäisyys ja kulttuurisen näkökulman puutteellisuus ovat osasyitä siihen, että suunnittelijoilla on vaikeaa ottaa huomioon kulttuurillisia tekijöitä. Ne ovat kuitenkin tärkeitä, sillä teknologia vaikuttaa ihmisten kokonaisvaltaiseen hyvinvointiin.

Tämä väitöskirja käsittelee kognitiotieteen näkökulmasta edellä mainittuja ongelmia. Tässä työssä ehdotetaan psykologiaan ja antropologiaan perustuvaa teoreettista mallia, joka esittää teknologian kulttuurisen ulottuvuuden, selittää kulttuurin ja teknologian vuorovaikutusta, sekä avustaa saamaan esille tuotesuunnittelulle tärkeitä kulttuurillisia näkökulmia, jotta tuotteet kohdistuisivat paremmin ihmisten tarpeisiin.

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APPENDIX: LITERATURE REVIEW SUMMARY

The questions that guided the sampling of articles reviewed are the following: How do researchers study the effects of culture on the design of ICT artefacts? At what stage of the design process do researchers study the relationships between sociocultural factors and ICT? The criteria for the articles search were: both culture and design of ICT were focal constructs, and publication in journals or conference proceedings within the past ten years—from 2002 to 2011. The following criteria were employed to further guide the selection of articles for inclusion in the review: (a) the study explicitly addresses cross-cultural ICT design, or design of ICT artefacts for a specific culture; (b) empirical studies (experimental or field studies), or theoretical studies must concentrate on cultural issues in the design of ICT. Whilst usability evaluation is an important part of the design process, articles dealing with the effects of culture on the usability testing process itself have been left out of the review. Clemmensen and Roese's (2010) work in international usability testing provides a recent report on the state of this sub-discipline.

Several methods were used to search for relevant articles: search of several electronic databases—Science Direct (Elsevier), ACM Digital Library, and IEEE Xplore Digital Library—by using the keywords "culture" and "ICT (or IT) design", or "HCI design"; examination of the bibliographies of articles in the initial sample, to find articles missed during the electronic database search. Each article was reviewed to determine its ICT design theme, conceptualization of the culture construct, variables used in the study, and relevant findings. The results of this analysis are presented in this appendix. Table 11 provides a list of the articles organised according to cultural themes and design objectives covered. Tables 12 – 12.3.3 further break down the summaries according to methodology and participant attributes, cultural model, and relevant findings. The data could serve as a basis for subsequent analysis to determine the gaps in the ICT design/comparative culture studies literature, and to propose directions for future research.

Sixty-three articles were reviewed. The studies in the sample share a common goal of identifying relevant cultural factors, and aligning them with an ICT artefact's user interface, functions, features, and related content. The survey points to a situation whereby usability issues concerning an artefact's user interface take the attention of most researchers. Their primary objective is to figure out how to fix culture-related problems that have been encountered after an artefact has been in use for some time. A typical approach to cross-cultural ICT design research of this type involves evaluation of an existing artefact's interface to improve its usability in cultures other than the one where it was initially introduced. Beyond this shared goal of improving usability, researchers diverged in their methods, and in the timing of their culture related investigations relative to the overall design process. Applying Hofstede's (1980/2001) cultural value dimensions in the methodology is the dominant practice among investigators who reported using a culture theory model—i.e., in fifty-seven percent of the articles. This trend has been observed already in previous literature reviews. Forty-three percent of the articles did not explicitly mention the use of a cultural model.

In terms of design objectives, the following themes have been identified:
(a) Realignment: thirty-one studies grouped under the realignment theme typically looked for conventional usability problems in existing ICT artefacts. There is an implicit notion in these studies that the original design of the artefact is basically sound. Therefore the task at hand is to figure out how the design could be adjusted in order to improve the usability of the artefact across different cultures.
(b) New functions search: seven studies in the new functions search category looked for similarities and differences in people's preferences, and aimed to introduce novel features and functions for existing artefacts. Whilst the study of cultural factors have obvious applications for making adjustments to the interface of existing artefacts, studies in this category differ from studies in the realignment group relative to their respective design goals.
(c) Research strategy proposal: twenty-five studies in this group focused on proposing a design research method, either for general applications, or application to a specific domain of action.

TABLE 11 Summary of culture themes by objectives.

Theme	**Design Objectives**		
	New functions search	**Strategy Proposal**	**Realignment**
Content and interface		Cassell, Geraghty, Gonzalez & Borland (2009) C. D. Lee (2003) Maunder, Marsden, Gruijters & Blake (2009) Verran & Christie (2007)	J. Chakraborty & Norcio (2009) Marcus (2002) Marcus & Alexander (2007) Mushtaha & de Troyer (2007) Sun (2007) Yusof & Zakaria (2007)
Content design	Faiola, Ho, Tarrant & MacDorman (2011) Kang (2009) Mushtaha & de Troyer (2009)	Chetty, Tucker & Blake (2004) De Angeli (2009) de Castro Salgado, de Souza & Leitão (2011) Eugene et al. (2009) George, Nesbitt, Gillard & Donovan (2010) L.V.A. Harris & Adamo-Villani (2009) Hsieh et al. (2009)	Kondratova & Goldfarb (2009) Luna, Peracchio & de Juan (2002) Amant (2005)

TABLE 11 continues.

TABLE 11 continued.

Theme	Design Objectives		
	New functions search	**Strategy Proposal**	**Realignment**
Content design		Irani, Vertesi, Dourish, Philipp & Grinter (2010) Kam, Mathur, Kumar & Canny (2009) Khaled, Barr, Fischer, Noble & Biddle (2006) Marcus (2006) Mazadi, Ghasem-Aghaee & Ören (2008) Nielsen, Bødker & Vatrapu (2010) Rauterberg (2006a) Rincón, Boutet, Coppin, Poirier, & Curieux (2011) Young (2008)	
Functions and features usability	Cui, Chipchase & Ichikawa (2007) H. Kim & Shade (2007) Nazir, Enz, Lim, Aylett & Cawsey (2009)	Chavan (2007) Rangaswamy & Singh (2009) Zakaria, Stanton & Sarker-Barney (2003)	
Interaction design		J. Lee (2009) Sheikh, Fields & Duncker (2009)	
Interface usability	Choi, Lee, Kim & Jeon (2005)		Alostath, Almoumen & Alostath (2009) Callahan (2006) C-H. Chen & Tsai (2007) Chen, Chiu & Lin (2007) Eune & Lee (2009) G. Ford & Kotzé (2005) Heimgärtner (2007) Heukelman & Obono (2009) Hope et al (2007) Jagne & Smith-Atakan (2006)

TABLE 11 continues.

TABLE 11 continued.

Theme	Design Objectives		
	New functions search	**Strategy Proposal**	**Realignment**
Interface usability			Jhangiani & Smith-Jackson (2007) J. Kim, Lee & You (2007) Knapp (2007) Li, Rau, & Hohmann (2011) Lin et al (2007) Oren et al. (2009) Paterson et al. (2011) Peranginangin, Chen & Shieh (2011) Reinecke & Bernstein (2007) Shen, Wooley & Prior (2006) Suadamara, Werner & Hunger (2011) Winschiers-Theophilus 2009)

TABLE 12 Literature review summaries.

Theme: Content design. Design objective: New functions search.			
Citation	**Methodology and Participant Attributes**	**Cultural Model[44]**	**Relevant finding(s)**
Faiola, Ho, Tarrant & MacDorman (2011)	Survey of 107 participants in the US and Korea.	na	U.S. and Korean participants described web pages using emotive adjectives with similar meanings, but they used adjectives with different meanings to describe aesthetic dimensions.
Kang (2009)	Multi-method (questionnaire and interviews) study of 62 Australians and 100 Koreans residing in Australia.	Hofstede (1980)	Korean preferences are characteristic of the collectivist trait. Australian preferences point to a mix of collectivist and individualist traits.

TABLE 12 continues.

[44] References for cultural models as cited by the author (s) of the article. *na - cultural model not explicitly mentioned.

TABLE 12 continued.

Theme: Content design. Design objective: New functions search.			
Citation	**Methodology and Participant Attributes**	**Cultural Model[45]**	**Relevant finding(s)**
Mushtaha & de Troyer (2009)	Multimethod (task performance and questionnaire) study of 50 website design experts from Malaysia, Greece, UK, Netherlands, US and Japan.	Hofstede (1991), Trompenaars (1995)	Five levels of cross-cultural markers are important for culture-centred website design (in the order of priority): context-dependent cultural markers, settled cultural markers, broad cultural markers, variable cultural markers and vista cultural markers.

TABLE 12.1.1

Theme: Functions and features usability. Design objective: New functions search.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Cui, Chipchase & Ichikawa (2007)	Survey (Interviews) of 1549 people on the streets of big cities in Finland, US, Italy, India, Japan, Korea, China, Iran and Uganda. Sixteen item paper-based questionnaire used.	Hofstede (1991/2004)	Limitation in the options for carrying mobile phones compromises users' ability to always notice incoming calls or messages. There are cultural differences in using phone straps, phone covers and stickers to personalize the physical appearance of the mobile phone.
H. Kim & Shade (2007)	Multi-method (interviews and collection cultural artefacts related to cohort and context) study on customers of a software company in Japan.	na	Target users as well as software space have to be examined to determine appropriate research and useful application features.

TABLE 12.1.1 continues.

45 References for cultural models as cited by the author (s) of the article. *na - cultural model not explicitly mentioned.

TABLE 12.1.1 continued.

Theme: Functions and features usability. Design objective: New functions search.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Nazir, Enz, Lim, Aylett & Cawsey (2009)	Theoretical	Hofstede & Hofstede (2005)	Proposed the culture-personality based affective model for application to affective synthetic characters in AI.

TABLE 12.1.2

Theme: Interface usability. Design objective: New functions search.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Choi, Lee, Kim & Jeon (2005)	Interviews of 24 participants (students and professionals) in Korea, Japan and Finland.	Hofstede (1980), Hall (1976)	Eleven of 52 design attributes for mobile data services showed clear correlation with the user's cultural profile.

TABLE 12.2

Theme: Content and interface. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Findings**
J. Chakraborty & Norcio (2009)	Theoretical	Hofstede (1991)	A cross-cultural hybrid user model to study the variables of colour, symbolism, individuality, knowledge processing and local variables could culturally inform designs of computer games.
Marcus (2002)	Theoretical	Hofstede (1997)	Cross-cultural analysis and design issues need to be integrated in the planning stages. Designers need to better understand the mappings of culture dimensions to UI components to dimensions such as trust and intelligence to make better decisions on usability, aesthetics and emotional experience.

TABLE 12.2 continues.

TABLE 12.2 continued.

Theme: Content and interface. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Findings**
Marcus & Alexander (2007)	Survey of 25 students and professionals, 20-50 years-old, from various countries, who have been living in San Francisco, California for less than 5 years. Used questionnaire to extract user preferences on usability and cultural dimensions of a financial website.	Hofstede (1997)	Cultural dimensions must be considered in order for a website to be effective.
Mushtaha & de Troyer (2007)	Multi-method (questionnaires, icon recognition exercises, observation, tasks and interviews) study of 42 Palestinian students and 21 Belgian students.	Hall (1990), Hofstede (1991), Trompenaars (1995)	Some cultural values of Palestinian and Belgian students seem to converge, but differences in the following cultural dimensions: individualism/collectivism, power distance, internal/external control, gender roles, achievement/ascription, affective/neutral, and universalism/particularism.
Sun (2007)	Multi-method (questionnaire, diary study, interview and observation) study of frequent users of SMS, 18 - 30 years old, in the US and China.	Fiske (1987), Geertz (1973), Hofstede (1991)	An activity approach to cross-cultural design integrates methodologies based on activity theory, genre theory and British cultural studies to gather data on cultural factors in the broad socio-cultural context and local immediate context. The approach could help in moving the focus from localization of operational affordances (e.g. translation of menus) to localization of social affordances.

TABLE 12.2 continues.

TABLE 12.2 continued.

Theme: Content and interface. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Findings**
Yusof & Zakaria (2007)	Theoretical	Hall (1976), Hall & Hall (1990)	Western-centric assumptions embedded in the design of virtual worlds are different from cultural values found in Eastern or Islamic cultures, therefore designers need to be fully aware of cultural fit vs. technological fit issues.

TABLE 12.2.1

Theme: Content design. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Findings**
Kondratova & Goldfarb (2009)	Evaluation of 100 websites to investigate cultural markers--i.e., colours, fonts, number of images and layout of webpages.	Hofstede (1991)	Developed a suite of tools and research methodologies that can be used by designers.
Luna, Peracchio & de Juan (2002)	Survey and user usage of websites study in the US and Spain.	Geertz (1973), Hofstede (1991/1997)	Website contents' congruity with a visitor's culture influences the likelihood of experiencing flow.
Amant (2005)	Theoretical	na	Cultural factors mediate online interaction behaviour as well as expectations about using communications technologies to exchange ideas. Designers have to consider various strategies for addressing variance.

TABLE 12.2.2

Theme: Interface usability. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Alostath, Almoumen & Alostath (2009)	Multi-method (questionnaire and task performance) study in Brazil, Kuwait, Egypt, and UK. Sixty-three participants in the task performance; 706 participants in the questionnaire.	Hall, Hofstede, Trompenaar, Victor	Design preferences research does not present effects of usability.
Callahan (2006)	Content analysis of websites in various countries.	Hofstede (1980, 1991)	Observed similarities and differences in web design can be viewed in terms of the Hofstede value dimensions, but the correlations were weaker than anticipated.
C-H. Chen & Tsai (2007)	Theoretical	Hall (1969)	The process of interface internationalization could provide the framework in which interface localization can be implemented by adding cultural factors into the design.
K. Chen, Chiu & Lin (2007)	Multi-method (interviews and questionnaire) study on expert designers and experienced users of mobile phones in Taiwan.	Hofstede (1991/1997)	Kansei needs vary from culture to culture because of diversity in usage habits.
Eune & Lee (2009)	Survey of 2211 internet users, 15 - 39 years old, in Korea, China and Japan.	Hofstede (2008), K.P. Lee (2001)	Eight cultural variables (drawing from K.P. Lee) linked with Hofstede's dimensions (PDI, IDV, MAS, UAI, LTO), were found useful in analysing user behaviours and preferences. Useful for market positioning.
G. Ford & Kotzé (2005)	Archive analysis of previous survey on 50 university students in South Africa.	Hofstede (2001), Hall (1959), Trompenaars (1993)	Result of the analysis was inconclusive and cannot be used to support the hypothesis that designing user interfaces to accommodate one side of Hofstede's value dimensions will result in better usability for all users regardless of cultural profiles.

TABLE 12.2.2 continues.

TABLE 12.2.2 continued.

Theme: Interface usability. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Heimgärtner (2007)	Two phased multi-method (collection of demographic data, test tasks, value survey module questionnaire, user's evaluation of results, and debriefing questionnaire) of students in Germany and China.	Hall (1959, 1976), Hofstede (1991)	Intercultural Interaction Analysis Tool uses usability tests to gather data on interaction behaviour with computer, and infer differences in cultural factors. The tool is useful in identifying cultural (design) variables such as colour, positioning, information density, interaction speed, interaction patterns and their values, thus enabling deduction of design rules for cross-cultural HCI design.
Heukelman & Obono (2009)	Survey of 72 staff members of a university's IT and computer science departments in South Africa.	na	African Village metaphor for computer interface is better suited for older African users. Culture-specific metaphors could improve usability for African users and contribute to improving computer literacy.
Hope et al (2007)	Observation of technology conference attendees' interaction with an information kiosk during a conference in Japan.	na	Effect of culture is contingent on the context, and conceptualization of culture as nationality may not be the most important indicator in multinational co-located settings like conferences.
Jagne & Smith-Atakan (2006)	Theoretical	Hofstede (1991), Hannerz (1992), Trompenaars (1993)	Designers should engage with cultures directly and create their own cultural framework for analysis (i.e., a strategy for cross-cultural interface design).

TABLE 12.2.2 continues.

TABLE 12.2.2 continued.

Theme: Interface usability. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Jhangiani & Smith-Jackson (2007)	Multi-method (questionnaire, focus group discussion) study on 69 users of mobile phones in India and US. Cohorts included a group of persons with disability, and a control group.	Hofstede (1991/1997)	Significant differences in preferences among disability and control groups concern physical features and hardware attributes of the mobile phone. Mobile phones designed for people with disabilities will enable more social interactions with the community. Perceived usability of phone interface was rated differently based on nationality and disability. The aesthetic appeal of the artefact must not be overlooked to ensure a pleasurable experience with the artefact.
J. Kim, Lee & You (2007)	Multi-method (questionnaire to collect demographic data and get participants with strong cultural identity; two usability tests using prototype) study on mobile phone users in Korea and Netherlands.	Nisbett, Peng & Norenzayan (2001)	Cognitive styles in categorization (i.e., relational or taxonomic) had significant correlation with types of menu structure for mobile phones.
Knapp (2007)	Multi-method (questionnaire about attractiveness of system; usability tasks) study on 98 participants (Germans and Chinese).	Na	Chinese user group's performance on tasks, and German user group's perception of navigation system's attractiveness were negatively affected if the location and grouping of functions in the system are based on the other group's mental models.

TABLE 12.2.2 continues.

TABLE 12.2.2 continued.

Theme: Interface usability. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Li, Rau, & Hohmann (2011)	Multi-method (interview and questionnaire) study of 60 Chinese and 72 German university students who use multi-party chat systems.	Hofstede (1980, 1991), Hall & Hall (1990)	Demonstrated difference in preference of multi-party chat, sending messages to offline contacts, and use of emoticons to increase response speed. Differences explained by individualistic versus collectivistic culture and low- versus high-context communication style.
Lin et al (2007)	Survey of 199 university students from Taiwan and US on Instant Messaging functions and icon recognition.	na	Cultural background is of significant importance on how users identify the functions associated with and assigned to icons.
Oren et al. (2009)	Questionnaire: for icon evaluation/usability experiments: seven tasks for users to complete	na	Identified key cultural design flaws and general usability problems in the iPhone and redesigned it to reduce the problems.
Paterson et al. (2011))	Multi-method (questionnaires, interviews; continuous and interactive observation) study of 14 participants (biologists and wildlife managers) in Namibia.	Hofstede (1980/1984, 1991/1997)	Difficult for Namibian users to evaluate functions of hypermedia system independent of content. Questionnaires are inappropriate for Namibia because participants tend to respond according to what they think are expected. Open-ended questions and dialogues seem to be more appropriate methods. Workshops work better than methods based on one-to-one interaction.
Peranginangin, Chen & Shieh (2011)	Survey of 52 university students from Indonesia.	Hofstede (1991)	Women and men have different perceptions of needs and preferences in design elements of the mobile phone.

TABLE 12.2.2 continues.

TABLE 12.2.2 continued.

Theme: Interface usability. Design objective: Realignment.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Reinecke & Bernstein (2007)	Theoretical	na	Artificial intelligence techniques could help automate cultural adaptation of user interfaces. The process of cultural modelling could use stereotypes and communities based on existing cultural models, to capture facets of a user's culture.
Shen, Wooley & Prior (2006)	Multi-method (questionnaire and usability testing) of 29 participants in China.	na	A garden metaphor is suitable for the Chinese socio-cultural context, and it can be applicable to other cultural contexts.
Suadamara, Werner & Hunger (2011)	Survey of 599 participants from Indonesia, Malaysia, and Germany.	na	Culture plays an important role in determining user's preference in working with groupware applications. Cultural specific preferences were significant in explaining usage behaviour in Indonesia and Malaysia, but not in Germany.
Winschiers-Theophilus 2009)	Theoretical	Hofstede (1991/997)	Experiences and theories in cross-cultural design and evaluation are not yet comprehensive, and only a full understanding of the cultural flow will facilitate integration.

*na - cultural model not explicitly mentioned

TABLE 12.3

Theme: Cultural fit; content and interface. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Cassell, Geraghty, Gonzalez & Borland (2009)	Observation of 40 children in the third-grade in the US.	na	Virtual peers designed in alignment with African American children's linguistic style encouraged code switching and modelling of appropriate science talk in the classroom.
C. D. Lee (2003)	Observation of students in underachieving African American urban high school in the US. Used a redesigned e-learning tool for science education as tool for literary response.	na	A framework like the "cultural modelling framework" could be employed to take into account cultural issues in the design of education computer tools. Including a cultural orientation to design can contribute to building situated theories of learning, help identify important basic questions, and better evaluate the differential effects of computer-based tools on learning.
Maunder, Marsden, Gruijters & Blake (2007)	Interviews of participants in two projects: nurses working rural clinics; illiterate animal trackers working in the national parks of South Africa.	na	User centred design approach should provide tools and techniques that probe socio-cultural attitudes toward technology to expose intricacies that affect the overall design of ICT artefacts.
Verran & Christie (2007)	Case study of a Yolngu aboriginal elder in Australia.	na	Digital technologies designed for representation cannot enable aboriginal persons to negotiate their metaphysics in doing their knowledge. Currently available hardware and software, based on Western metaphysics, cannot allow a performativeness that embodies the uniqueness of each presentation so essential to Yolngu metaphysics.

TABLE 12.3.1

Theme: Cultural fit; content design. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Chetty, Tucker & Blake (2004)	Task performance for doctors and nurses working in rural areas of South Africa	na	Introducing customized technology for the needs of people in rural areas must be supplemented with intensive training for individuals who will use the technology.
De Angeli (2009)	Two-phased surveys of 219 university students who were born in the UK or China, and residing in the UK.	Hall (1976), Hofstede (2001), Markus & Kitayama (1991)	A user's cultural identity pervades on-line self-presentation, influencing communication style and design preferences.
de Castro Salgado, de Souza & Leitão (2011)	Multimethod (task performance and post-performance interview) of six website designers.	na	Cultural viewpoint metaphors (CVM), a conceptual design tool for embedding cultural diversity in systems design.
Eugene et al. (2009)	Theoretical	na	A "cultural relevance design framework", which describes practices, ontology, representation, and tasks should support creation of education technology. The framework helps uncover designers' beliefs and biases about their target audience, highlight aspects about the target audience, and suggest cultural assets for investigation, and use to build cultural representations.
George, Nesbitt, Gillard & Donovan (2010)	Theoretical	Hofstede (1991/2005)	User centred design approach should be applied in designing and building websites for indigenous communities.
L.V.A. Harris & Adamo-Villani (2009)	Multi-method (questionnaire and workshop) field study of 45 youths, 12 - 18 years old, in Mexico.	na	Interactive media such as serious games could play a role in encouraging underserved populations to understand and change unhealthy behaviour, such as those related to HIV.

TABLE 12.3.1 continues.

TABLE 12.3.1 continued.

Theme: Cultural fit; content design. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Hsieh, Holland & Young (2009)	Theoretical	Hofstede (2005), Hall & Hall (1990)	A theoretical model consisting of four stages: understand the context of use, define a cultural model for the target culture, website design production, evaluate the effectiveness of web communication.
Irani, Vertesi, Dourish, Philipp & Grinter (2010)	Theoretical	na	Attention to hybrid practices in ICT design together with sensitivity to how inequality in power relations are enacted in design practice could improve understanding of the diversity in design practice, and the reasons for the variance.
Kam, Mathur, Kumar & Canny (2009)	Observation of rural children in India.	na	Prior experiences with Western-style games led to cultural expectations creeping into processes and design outcomes.
Khaled, Barr, Fischer, Noble & Biddle (2006)	Interviews of 15 university students in New Zealand.	Hofstede (1991/1996)	New Zealand Europeans and Maoris differ in their perceptions of the role of will individual power, influence of others, social and cultural norms regarding smoking and cessation of cigarette smoking. These differences have implications on the design of persuasive technology.
Marcus (2006)	Theoretical	Hofstede (1991/1997)	User experience development must account for cultural differences and similarities.
Mazadi, Ghasem-Aghaee & Ören (2008)	Theoretical	Hofstede (1980), Schwartz (2003, 2006)	The proposed cultural model for intelligent agents enables exploration of new behavioural aspects of these agents in various virtual environments.

TABLE 12.3.1 continues.

TABLE 12.3.1 continued.

Theme: Cultural fit; content design. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Nielsen, Bødker & Vatrapu (2010)	Theoretical	na	Whilst the Scandinavian approach to participatory design could serve as a starting point for designing ICT, one must recognize that assumptions embedded in the Scandinavian tradition might not translate to contexts with different sociocultural knowledge, and infrastructure.
Rauterberg (2006a))	Multi-method (task performance, observation, interviews) of participants in an augmented reality environment in the Netherlands.	na	Western culture is characterized by analytical reasoning based on formal logic. Cultural computing projects in Western cultures should be aligned with their traditions. The story Alice in Wonderland could be a basis for an interactive experience to address cultural determinants. Cultural awareness could be assessed through the concept of mandala as introduced by Carl Jung.
Rincón, Boutet, Coppin, Poirier, & Curieux (2011)	Observation of indigenous community in Columbia.	Kluckholm & Strodtbeck (1961), Hofstede & Hofstede (2005)	Proposal for a cultural model consisting of the variables: Language, Space, Environment and technology, Social organization, Notion of time, and Nonverbal signs.
Young (2008)	Theoretical	na	Integrating culture in ICT design serves a broader scope, and design has not caught up with technology.

TABLE 12.3.2

Theme: Cultural fit; functions and features usability. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Chavan (2007)	Theoretical	na	Tensions between cultural ideals and cultural practice, i.e., cultural strains, present opportunities for design solutions.
Rangaswamy & Singh (2009)	Multi-method (focus groups, open ended interview, family case studies, participant observation) study on low middle-income families in India.	na	The notion of mobile phones as private, personal and individual might not be valid in India. Calls for more research in personalizing shared mobile phones. Will needs for new media outside of Europe, Japan and the US follow the same trajectory of individualization, multiplication and personalization?
Zakaria, Stanton & Sarker-Barney (2003)	Theoretical, Middle-Eastern culture.	Hall (1976)	Arabic values, prioritized for building consensus, and creating family-like environment, have to be explicitly transformed into software features for community building and establishing trust relationships.

*na - cultural model not explicitly mentioned

TABLE 12.3.3

Theme: Cultural fit; interaction design. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
J. Lee (2009)	Multi-method (task performance and observation) study participants in Visual-talk table interactive system in Finland.	Hall (1976/1981), Hofstede (1991)	A conceptual framework of "co-experience" can be used to explain how cultural variations in role-taking can predict variations in user co-experience. Implications for interaction design: cultural co-experience can culturally sensitize concepts for new design.

TABLE 12.3.3 continues.

TABLE 12.3.3 continued.

Theme: Cultural fit; interaction design. Design objective: Strategy proposal.			
Citation	**Methodology and Participant Attributes**	**Cultural Model**	**Relevant finding(s)**
Sheikh, Fields & Duncker (2009)	Task performance (card-sorting) study of 160 participants in the UK and Pakistan.	na	Differences were found in terms of categorization.