Development of an Evidence Based Toolkit to Support Safe Design for Children

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ABSTRACT

Visual safety information for children is not well documented. The objective of this research was to identify key issues and requirements at each stage of the design lifecycle. The development and future implementation of a guide seeks to convert evidence-based guidelines into working tools for design practitioners. Semi-Structured Interviews (n=30) conducted August- October 2013 with experts involved in working with children. Including, designers, organisations, child safety experts, applied child development specialists, testing groups, paediatric, academic, Ergonomic and Human Factors Experts. Initial analysis of the interviews identified the main problems with implementing Human Factors and Ergonomics guidance, as well as knowledge needs of design practitioners and other experts. Results look towards development of the toolset to promote a more holistic prevention/ view of safety. Key issues in implementation of the toolset include lack of an accessible format, differences between groups involved in promoting safety, lack of co-ordination between the groups and further national and regional factors.

Keywords: Safety Information, Design, Lifecycle, Design for Children

INTRODUCTION

Every year within the UK, one million accidents occur to children under the age of 15. These accidents have varying degrees of severity. Epidemiological data- indicate that most minor injuries to young children occur in and around the home (RoSPA, 2012). A significant number of accidents and minor injuries also occur in other contexts (e.g., travel by train – RSSB, 2009). There is an increasing awareness of the need to promote safety for children through design, (Wilson and Norris, 1993). In previous work a set of guidelines were designed and tested (targeted at industrial/product designers and manufacturers) for the design and evaluation of warning signs for young children (5-11 years of age) and their carers (Waterson and Monk, 2013; Waterson et al., 2012). The work involved close engagement with a diverse range of stakeholders. The new guidelines covered aspects of both the design (e.g., use of colours, pictograms) and evaluation (e.g., use of discussion groups) of warning signs for young children. This highlighted the need for further research across various disciplines (Waterson and Monk, 2014)

Both internal and external factors influence children's susceptibility to unintentional injury. Internal factors include the quickly changing characteristics throughout child development stages. Cognitive and emotional changes can have implications for their awareness of environmental hazards and warnings. Fundamentally, there are very few guidelines covering physical, psychological and behavioural characteristics of children aged 5-11. Hence, problematic products, systems or services which have not taken interaction with children into account are all too common. Safe Design is a key element of reducing accidental and unintentional injuries. External influences exist where the majority of the environment is designed for adults and not children (ISO, Guide 50, 2014). Caregivers often over-estimate a child's ability at different stages of development, further exposing them to hazards. One way of promoting safety is to provide evidence based tools which aim to help design products which minimise hazards, and includes information which alerts young children and their carers to the dangers of misuse. However, key

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difficulties also exist in applying ergonomic data and information regarding young children. As discussed, cognition and capabilities vary greatly at different stages of development. The stage of development, for example within one product construction or service standard, might be necessary to protect children of different ages against different hazards using very different means. This, together with their exposure to hazards (including lack of awareness susceptibility to injury) puts them at risk of harm in ways different from adults.

This study takes the previous guidelines and determines difficulties that are faced in implementing human factors and ergonomics guidance within the design environment. The emphasis is placed on HF/E information and guidance which centres on the needs of the intended users, in this case children. The preliminary results consider the gaps and then go on to discuss any improvements that can be made in the form of support for the designer. Overall, the research looks towards the development of a resource or 'visual aid', in the form of booklets, cards, infographic materials and animations. Infographics are 'graphic visual representations intended to present complex information quickly and clearly' (Smiciklas, 2012). The information and data in the tools will help to outline children's development, explaining how this leads to different approaches to promoting safety than from those used to meet the needs of adults. Furthermore it will enable a better understanding and awareness amongst stakeholders, of the specific safety needs, and requirements of young children, and their carer's.

HUMAN FACTORS/ ERGONOMICS GUIDANCE

In the aforementioned ways, accidental injury takes a heavy toll of society, particularly children and older people. Children are not small adults and there is a need to provide designers with a usable set of information resources which will better inform them of the unique characteristics of children and differences in design data in comparison with adults. However current information is often piece meal and lacks an accessible format when used by designers and manufacturers. Currently there is no support in the form of information- based yet simple to use human factors guidance. Data has been collected, including Child data (Wilson and Norris, 1999). ISO/IEC Guide 50 provides an alternative hazard- based approach that might be more convenient for products, constructions and services intended primarily for young children. One way of reducing these accidents is to design safety information (e.g. signs, product leaflets, labels) which can alert young children and their carers to hazards or potentially unsafe behaviours. As well as these, visual tools have the potential to aid designers/ manufacturers working with young children as their target audience.

In relevance to the development of H/FE information considered within this section, the challenges and opportunities for risk communication posed are due to increased volumes and sources of information, technological advances, and globalization's call for consistency as well as specificity across and within nations and cultures. (Riley, 2013) The information/ data which is available is often complex and difficult to interpret (e.g., anthropometric data), as well as hard to find (e.g. cognitive abilities). Barriers often include as described above, the 'unavailability, inaccessibility, and inapplicability of data' (Wilson and Norris 1993). Currently available information/data is often complex and difficult to interpret (e.g. anthropometric data), as well as hard to find (e.g. cognitive abilities). Currently there is no support in the form of simple-to-use human factors/design tools for designers/manufacturers working with young children as their target audience. This stands in contrast to information of this kind which is available for adults and guidance developed for specific user groups of specific individuals, for example visually impaired and other types of disabled users, Barker and Fraser, 2000: Royal College of Art, 2012. Similar tools which have been developed for adults and inclusive populations, have proved successful and have made a significant contribution to design for safety. The emphasis will therefore be placed on examining the systems approach to warning design which centres on the needs of the intended users, in this case children. (McLaughlin, 2012) An important consideration, as described by (Waterson and Monk, 2013) is that comprehension and interpretation are likely to be joint processes involving interactions with adults and other care givers.

In this work the requirements of the support tool for designers and the barriers for implementation, of the design aid at different stages within the lifecycle of design for children aimed to be determined. The purpose of this is for the guidelines to be used, the scope of these expanded and used as a basis to produce a toolkit which can help designers to understand the physical, cognitive and behavioural characteristics of infants and young children. This work looks towards a resource in the form of an evidence -based- toolkit for designers providing visual aids for designers and manufacturers when designing for young children. Furthermore, the future development of this resource will provide ideas for evaluating and testing products with young children.

AIMS

The overall objective is to take previous work on the development of guidelines covering the design and evaluation of visual information for young children (e.g., signs, labels, safety characteristics) and turn them into a set of tools comprising of resource packs, cards and infographic materials. Research is required for inputs into the design requirements, to seek how evidence can best be turned into practice, to improve safety for young children.

This involves (4) aims:

- Collation of available information sources (safety guidelines covering design and evaluation- Waterson and Monk, 2013; Waterson et al., 2012; CAPT; Anthropometric data) Specification of tools covering content, format and options for presentation.
- Assessment of designers Information needs contributing to the future development of a toolkit in the form of information sources and usable guidance for design practitioners. (interviews, presentations and feedback on designs.)
- Provide designers with usable design guidance and ideas for methods for to use when working with children.
- Development of Infographics: To reduce time spent by practitioners in finding suitable materials or understanding complex guidance.

The future development of the evidence based toolkit aims to facilitate understanding amongst designers and other stakeholders of the specific safety needs and requirements of young children and their carers provide ideas for designers with ideas to evaluate and test their products with young children. In addition to the research into warning theories, there are a number of issues facing manufacturers, design practitioners and other professionals involved in the process. With regards to safety aspects and design for children, the review of how design for young children functions, for example lifecycle, sources of information and problems aim to be identified. A better thorough understanding of the needs and requirements of design practitioners should have been achieved. This will facilitate the design of interventions aimed at increasing the effectiveness of safety information to potentially reduce the number of accidents or injuries and thus save time and cost for NHS.

METHODS

Methods adopted for the initial study include, documentary analysis of recommended reports, from external experts, providing an overview of previous work in accidental injury and statistics for young children. Consultation with external experts and key researchers were sought throughout the study, including Semi structured interviews with various groups, commercial organisations (standards), academics, public health experts, and design professionals. This study consists of interviews with researchers who have worked with children (30 semi-structured interviews) with subject matter experts to identify the most useful, design-applicable resource.

Participant Background	Number of Participants
Human Factors Researchers and Consultants	5
Child Development Expert	2
Architect /Urban Designer	2
Industrial Designers	2
Inclusive Designer	2
Children's product Designers	3
Author's	3
Child Accident and Prevention Trust	2
Academics	5
Professor of Paediatric Epidemiology (Child Health) Associate Academic (Institute of Health and Wellbeing) Public Health Physician	1
Trading standards and product testing managers	3

Total = 30

PRELIMINARY FINDINGS

Emerging issues:

Current sources used by design practitioners include property data, standards and legislation. Most sources of information (e.g., anthropometric) collected on children is proprietary data owned by the manufacturing company concerned. Obtaining this data is difficult and costly and it is often inaccessible, piecemeal or hard to follow. The legislation covering the safety of toys etc. changes with regard to the age of the child and contexts are dependent upon the type of product and environment. Conflicts further exist where there are differences between stakeholders in the production process, as many are involved across the supply chain and design of the product, system or service.

Although UK standards are high imported goods often fall into this category. Problems exist due to the fact that the products are sometimes not rigorously assessed in line with changes in standards. Types of company or organisations vary in their approach. Some carry out their own product testing in house, whilst smaller companies lack sufficient resources. Additionally pressures arise from Marketing Specialists. Industrial designers are often briefed by these marketing experts and are not often involved with the initial user research i.e. focus groups etc. Manufacturers are often not UK based, resulting in the sourcing of different components from diverse sources. This makes it harder to see the variation in component quality and thus, generates problems in keeping track of sources. U.K. Trading Standards have expressed the need for monitoring and evaluation of goods at a national level. At present this takes place at a local level but findings are not always recorded centrally into a database to enable guidelines to be produced. Guidelines may be taken up by bigger companies whose products are already pretty much compliant with standards but again certain companies do not do this. Certain companies choose not to comply with legislation although they have the resources to do so; stores where their pricing policy is their main marketing tool are guilty of this practice.

Products which meet the standards are not always intrinsically safe conversely; products which do not meet standards are not always unsafe. They should be considered within a wider context of use, misuse and their developmental stage. Moreover, the user themselves can cause a product to be unsafe through misuse. This can be by not following instructions correctly or modifying the design.

REQUIREMENTS OF A SUPPORT TOOL FOR DESIGNERS

Components: Table_1: Forms of support for the designer: Design Guidance and Constraints

Designer Needs	Tools	Constraints
The resource needs to be easy to understand, time efficient i.e. available in a quick and an accessible format for use.	Provide a website Define guidelines. Examples of good practice	Authorship Proprietary Data
Know user group (child-users), including limitations and aspirations. To gain information on child-users that becomes developmentally situated and contextually valid.	Define developmental Stages Develop child-based personas	Policy or ethical issues, which make it difficult for children to be fully involved in the design process.
Methods used for working with young children groups/ extracting information from children	Describe participatory techniques and methods which are useful for extracting information from and working with young	Gathering useful information for innovation can be more difficult for children than for adults. One particular problem is the interchangeability of a

	children. Outline the Ethical considerations of working with children.	design problem Cognitive psychologists have shown that children find it difficult to conceptualise ideas that are abstract in nature
Factors that influence product use or handling by children in general	Define child- appealing characteristics of products	Where the responsibility leaves the designer or manufacturer and moves to the carer /user themselves i.e. modification or misuse of a product despite the original intent of the manufacturer.
Need to consider the users task in line with capabilities. Changing contexts are dependent upon the type of product and environment.	Taxonomy of children's products requiring different aspects such as Cognitive, Balance, Physical, Vision, Sound, Environment.	Parental expectations of their children's safety, often over or underestimate child's ability at different stages of development.
Implementation at national, regional and local level across sectors.	Implement resources covering required skills knowledgebase to fill the gaps. Implement a framework /Design Lifecycle.	Different problems exist in different areas with different products/ environments. Often manufacturers are not UK based.
Key safety, design, packaging and other issues to be considered in relation to products.	Define safety requirements in line with accidents.	Differences exist between groups. The design community are creatively motivated and don't often like constraints, conversely the job of human Factors specialists is to constrain designers.
Implications for designers/Manufacturers	Outline current standards and Legislation that are relevant.	There are examples of products that are intended for use by children, but that are used by younger age groups than originally intended. Such products might lack proper standards reflecting the age of current users.
Child development and behaviour	Children's body size and anthropometric data Motor Development Physiological development Cognitive development	Individual differences in Gender, Cultural, attitudes, beliefs.
Hazards relevant for children, e.g. Gaps and openings Sharp edges and points, electrical appliances, etc.	Define hazards relevant for the age- range.	Certain demographic groups seem to be out of reach of certain levels of information with various things including products safety.

KNOWLEDGE NEEDS OF DESIGN PRACTITIONERS AND OTHER GROUPS

Design practitioners are often faced with various difficulties when designing for a specific population (i.e. children, elderly). Expert interviews were used to identify issues in implementing human factors/ergonomics information and resources aimed at providing a useful 'visual aid' for designers and other experts. Initial coding and emerging themes were produced; further analysis of interviews identified the knowledge needs of design professionals and other experts. Relevant models and methods, including previously developed guidelines within the scope of the areas contributed towards the development of a support framework, future work will develop upon this initial framework. Sources of Support/input for Design aim to be identified in line with the design lifecycle and developed framework.

This research has evaluated the complexity of designing visual safety information for young children has both discussed and analysed this within the initial coding structure and the scope of the total risk communication environment. The design of visual information for children is not well accounted for therefore applying a systems approach aims to take a more holistic and hence, comprehensive view. In fact, the potential to apply "systems thinking" is realised within recent studies (McLaughlin et al., 2012). Indeed the development of this research has confirmed this view and will continue to look further at the social and environmental impacts (in all stages of the life cycle) pertaining to the design of visual safety information for young children. Further testing and refinement of the Guidelines contribute to the future development of a Toolkit. Implementation is important across the different sectors including Marketing experts, Industrial designers, design engineers; Manufacturers, Customs/Importers, Distributers, Trading Standards experts, and Product Testing experts. The outcomes of the study are suggestions towards more comprehensive approach towards the design of products, systems and services for children within the defined age group.

U.K. Trading Standards have pointed to concerns over monitoring and evaluation of goods at a local and not a national level. At present this takes place at a local level but findings are not always recorded centrally into a database to enable guidelines to be produced. Likewise, usable resources for designers and manufacturers require a gateway to give access to visual information to acquire a better knowledgebase for the design of products and services for young children. One way of providing time efficient information, in a fast and readily accessible format is in the development of a website in order to provide online resources such as cards, infographic materials and animations.

Emerging from the interviews is the need to consider the user, task environment. Practitioners and experts commonly discussed that the design requirements for designing for young children were similar to that of designing for adults where it needs to be considered within the context of user, task and environment. One human factors and ergonomics expert, with experience in design for children, further discusses this in suggesting questions that should be asked by the design team, "what are the physical constraints that are defined by my user group? Who are my user group, what do they want to do and where do they want to do it? " Further constrains were then discussed "you've got a changing population in a changing environment and that's difficult to then produce anything useful from to advise or inform the third party, the creative team" An interview with the Child Accident and Prevention Trust (CAPT), identified similar reasons for unsafe products.

The main outcomes and considerations attained from the research were the requirements of a support tool for designers and other experts involved in working with young children, aged 7-11 years. Gaps in designer's information needs and the provision of relevant toolset components are summarized within Table_1. There may be a need for making resources available in different languages or in pictorial formats for people who have poor literacy. Findings suggest a lack of knowledge and usable evidence based guidance for designing visual safety information in relation to factors surrounding young children, for example the varying developmental stages. Thus the need to provide and further develop evidence-

based support for the designer in more accessible and easy to use formats. Human Factors/ ergonomics should be implemented straight away, at the initial stages of the design process. Specific safety needs of young children and their carer's are often not well understood. Often designers lack the relevant resources or information at the relevant time. In addition to this standards, and probably product design changes are never rigorously evaluated in terms of change in injuries. Products need to fit the developmental stage of the child. Some designers attempt to put together products encompassing different levels of co-ordination with inevitable results. The rapid alert system of the European Commission, RAPEX, reported the following: that the second, most frequently, identified category of serious risk notifications in 2013 was in relation to toys. The fourth was childcare articles and children's equipment – all products specifically designed for children. (European Commission, 2013)

Considering the whole environment and design lifecycle, a systems approach to safety goes beyond ensuring that the product meets the relevant standards, as discussed by the Trading Standards "just because a product meets the relevant standards, it does not mean that product intrinsically safe." Consumer education may be one way of reducing the gaps in knowledge and further ensuring the products are not modified within the user environment to create further hazards. Interventions across social groups could be in the form of information and guidance such as making current H/FE guidance into a 'visual aid' for designers closing the gap between both groups. Further interventions could be consumer education where there seems to be a lack of awareness or knowledge surrounding product safety certain dangers of misuse. The key limitations of looking at particular sub-group have been recognized within the findings hence suggestions for future research can be concluded. Relevant and up to date knowledge has been identified, as well as a theoretical grounding; prior studies on particular subgroups along with the contributions for future research have been discussed. The developed framework provides an initial exploration, which has identified prior research, building a theoretical knowledge base, including models and principles, and examples and characteristics of the design of visual safety information.

FUTURE WORK

A stronger infrastructure aims to be established that will be capable of achieving further, sustained reductions of unintentional injuries. Future work aims to consider the findings of this study, including emerging issues and information needs of design practitioners and promote knowledge transfer, to further translate these into a more economical and desirable format. Phases include tool development, (development and evaluation of a prototype), including feedback from designers i.e. using the toolset with the case studies, liaison with researchers, developers and users. A systematic evaluation of the tools will be carried out, assessing their impact on design activity. Evaluation will consist of impacts of time, costs, ratings of usefulness by designers and manufacturers evaluating any changes in designer's attitudes and behaviour. Consultation with external experts including child psychologist, throughout the study will be advantageous. The impact of the new tools will be societal, namely increasing the awareness and ability of the various stakeholders involved, to design safer products for young children. Longer-term the tools may contribute to reductions in the number of accidents amongst young children in the UK.

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