The Design of Operational Interfaces for Older Adults

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

Increasing numbers of older people are living independently for longer. The ability to use domestic information-processing appliances, such as washing machines and microwave ovens, to carry out activities of daily living is an important aspect of independent living. The focus of this research was on the design of operational interfaces on domestic information-processing appliances for older adults.

Inclusive and user centred design are used to create operational interfaces that address users' ergonomic needs. An early study carried out as part of this research identified unclear relationships between operational interfaces and instructional materials, such as cooking instructions on food packaging or washing instructions on clothes, as a major concern. Two impediments to the flow of a task were identified: interaction breakdown (where the task is stalled) and focus shift (where a user is distracted from the task).

Given the importance of these to the use and therefore design of the operational interface, a coding scheme was developed to enable systematic analysis of participants' interactions with operational interfaces and associated instructional information. The coding scheme covers participants' interactions with operational interfaces and the task being carried out. The research concluded that inability to use operational interfaces was because of limited connections between visual instructions on the interfaces and instructional materials. Also, habitual behaviours demonstrated in the routine activities could be used to design improved visual instructions and information in sequential series on operational interfaces.

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Preface

The research study was undertaken at the University of Leeds, where I undertook the degree of Doctor of Philosophy.

Chapter 1
Introduction

The UK population is growing and ageing. If recent patterns continue, individuals born in 1980 could expect to live on average 89 years. This increases to over 94 years for individuals born in 2015. Based on current projections, by 2037, individuals could expect to live on average 97 years (Office of National Statistics (NOS 2016). In the UK, the number of older people living independently in their homes is expected to increase, while the number of people available to provide specialist and non-specialist care is expected to decrease Pirkl (2009). Demands on public services, family fragmentation and geographical dispersal of relatives means that older adults are living alone for longer periods of time. With life expectancy increasing, the effects of older adults living longer will require improved understanding of what older adults need from their homes and domestic environments and designs of consumer products that address these needs.

Undertaking a masters degree in Industrial Design at the Royal College of Art, London in 1998 sensitized the author to the difficulties experienced by older adults in activities of daily living. Exposure to the daily experiences of stroke recovery and rehabilitation patients, as part of a design project whose goal was to improve independence through the design of tableware, provided insights on the reality of older adults with age related cognitive decline Morris & McKay (2009). These insights included aspects and the effects of ageing, and how to respond to the aging process through

improved product designs. This PhD study built on these insights by concentrating on activities of daily living and the design of household appliances with a focus on operational interfaces designed for older adults.

Independent living requires an ability to carry out activities of daily living in public spaces and within the home Holt (2006). Lyubomirsky et al. (2005) argue that, for older adults, participation in 'intentional' activities can facilitate independence and well-being. They suggest that older adults who are able to continue activities of daily living which have become routine or habitual, for example, washing, cleaning and cooking, gain higher levels of independence and autonomy. Seligman (2011) argues that although routine and habitual behaviours are the ideal for wellbeing, for many, living independently combines positive emotions, relationships, meaningful and purposeful activities, and more importantly accomplishments such as success and achievement.

Malinowsky et al's (2012) study on ageing and living independently provides insights on the challenges faced by older adults who experience reduced independence. (Rosenberg 2009a & 2009b) argue that the negative effects on older adults' quality of life lead to higher health and social costs. He suggest that product designers can facilitate and enable independence through effective design of household products.

A number of research projects have defined the landscape to improve products, devices, services for older adults in kitchen environments. For

example, the ‘Life Long Kitchen’[1] project (2016) aimed to improve the quality of life of older people. Hunter (2016) observes how older adults continue to stay living independently, safe in the knowledge that their nutritional needs and wishes are being met. Empirical studies have found that older adults living independently in their homes rely on domestic information-processing appliances such as cookers and microwave ovens to meet their nutritional needs. Bharucha et al. (2009) argue that there is an increase in the number of information-processing appliances that respond to the physical and cognitive needs of older adults. Studies by Wilkinson & De Angeli (2014) argues that many of the features on operational interfaces can support appliance usability. However, operational interfaces on such appliances remain inaccessible to many older adults. For example, older adults experience difficulties with operations on washing machine and microwave oven operational interfaces. Such difficulties have a disproportionate effect on older adults information-processing abilities and interactions. Operational interfaces that include complex elements, such as menu systems have detrimental effects on usability. Often associated with technological innovation, Maguire et al. (2014) suggest that these novel features lead to older adults becoming unwilling to use domestic information-processing appliances.

Empirical studies on older adults’ use of operational interfaces on domestic information-processing appliances are variable. Research has focused on four main areas: developing new technology and systems; understanding

[1] The Life Long Kitchen project is a multidisciplinary research initiative funding by New Dynamics of Ageing ((NDA) http://www.lifelongkitchens.org/advisory-group.html)

consumer choices; providing standards and guidelines; and designing methods for improving research. (Mugge & Schoormans, 2012a & 2012b) argue that to provide standards and guidelines, an understanding of how older adults use operational interfaces is required. Jones & Sarter (2008) suggests that poor feedback and the complex arrangement of operational interface features are, a major cause of experienced difficulties. Furthermore, these operational interface features cause breakdowns in human-machine interaction. Park (2011) argues that improved methods for operational interface design requires greater knowledge about older adults' interactions and information-processing activities. Moreover, he suggests that data should be acquired in the context of analyses of human activities.

Malinowsky et al. (2010) argues that the most common reported operational interface issues are related to information design on the interface specifically, how they are intended to be actioned. Shneiderman, (2010) argues that information on operational interfaces tends not to conform to inclusive and user centred design principles. Kemper et al. (2008) observe that older adults experience a range of difficulties with information on operational interfaces, which has a detrimental impact on, understanding and decision making based upon them. Understanding the influences and use of information by older adults has the potential to improve operational interface designs for older adults, thus, contributing to improved well-being and independence. This is the focus of this thesis.

1.1 Research Scope

Many older adults live and cope with less than full information-processing ability. Product designers can facilitate and enable older adults' interactions

and information-processing activities if they understand the procedures and operational sequences used in tasks. The research reported in this thesis explores the value of articulating older adults' information-processing activities and interactions for the design of operational interfaces. Moreover, the research identifies older adults' operational sequences, procedures, actions, operations and activities using domestic information–processing appliances. In addition, the thesis provides insights on factors that affect information-processing activities and interactions with operational interfaces on domestic information-processing appliances.

Policy makers and older people recognise that there is a need for operational interface designs targeted at the older consumer. Products designed for the changing needs of older adults are in demand Clarkson et al. (2013). Addressing the expectations of older adults requires an understanding of operational interface issues associated with operational features and the processes, procedures and operations used by older adults. The research challenge lies in understanding the range of approaches, techniques and methods used by older adults to process information and carry out activities of daily living, such as washing bedding using a washing machine and heating a pre-cooked ready meal using a microwave oven.

1.2 Aim & Objectives

The aim of this research was to explore approaches for supporting independent living through the design of operational interfaces that mirror the real-life processes in activities of daily living. It is important to consider interactions and information-processing amongst older adults with age

related cognitive decline because of the effects of reduced information-processing abilities, and older adults' experiences and perceptions of performing tasks with domestic information-processing appliances. The overarching research question addressed by the research was,

"What types of operational user interface can support older adults with reduced information processing capabilities in using domestic information-processing appliances more effectively?"

The following objectives were pursued.

1. Determine ways in which designers respond to the changing needs of older adults in the design of operational interfaces on domestic information-processing appliances through a review of literature.
2. Identify operational interface design goals through observations of older adults using operational interfaces on domestic information-processing appliances to carry out activities of daily living.
3. Establish evaluative performance criteria to enable the design, development and assessment of an alternative operational interfaces for a domestic information-processing appliance.
4. Design and develop an alternative operational interface for a domestic information-processing appliance and evaluate its effect on older adults' interactions.
5. Establish a framework to enable the assessment of interactions and information-processing activities in the use of operational interfaces.
6. Evaluate the framework by using it to analyse the effects that information-processing has on older adult interactions with domestic information-processing appliances.

1.3 Structure of Thesis

The thesis is positioned on three overlapping areas: product design, older adults and domestic information-processing appliance design. Figure 1.1 gives an overview of the topics covered in this study.

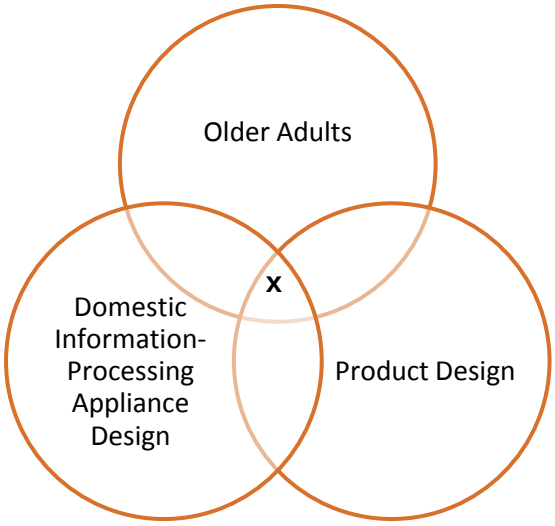


Figure 1.1 Overlapping Intersections Between Topic Areas

Chapter 2, outlines approaches used by product designers to design operational interfaces for older adults. Theoretical dimensions of information-processing and the ageing process are also outlined. In Chapter 3, the methodological approach used and the experimental design used in the research study are introduced.

Chapters 4-7 reflect the structure of the research process used. Chapter 4, provides insights on how two participants interacted with appliances. The characteristics of operating system design including hardware, software and menu systems on a microwave oven and a washing machine are explored.

Naturalistic inquiry case studies focused on participants' activities and goals. Evaluative performance criteria are introduced in this chapter and were used to describe characteristics of interactions using domestic information-processing appliances.

Chapter 5 provides a more detailed understanding of how the participants interacted with the operational interfaces and the instructional materials. Characteristics of sequential operations, operational procedure and information-processing activities are explored. A coding scheme for use in the analysis of the interactions and information-processing with operational interface is established.

Chapter 6 compares a new operational interface design based on evaluative performance criteria for a microwave oven with the current one. The development of the new operational interface itself is summarised in Appendix A. The study provides insight on how eight participants interacted with two different operational interfaces. The coding scheme was used in the analysis of the interactions and information-processing activities using the new and current operational interfaces. In Chapter 7, conclusions are drawn and recommendation for future and further studies are made.

Chapter 2
Literature Review

The literature focuses on the three broad topics: how older adults use domestic information-processing appliances; how older adults use operational interfaces; and how product designers might improve the design of operational interfaces for domestic information-processing appliances. Theoretical dimensions of information-processing and ageing are summarised.

2.1 Activities of Daily Living

Given anticipated changes associated with an ageing population, a key challenge for product designers is to respond with solutions that enable older adults to live independently for longer. Consumer appliances often referred to as white goods, task-specific appliances or 'domestic information-processing appliances are widely used in activities of daily living. Examples of domestic information-processing appliances include washing machines, dishwashers and microwave ovens. As such the design of consumer appliances that are better suited to the needs of older adults is becoming increasingly important.

A number of studies have identified a need for improved visual instructions and directions on the user interfaces of domestic information-processing appliances. Visual instructions and directions used on these products are typically communicated through the design and location of interface elements such as switches, buttons and control knobs. Consumer

dissatisfaction is often the result of multiple errors in use caused by complex arrangements of visual instructions and directions on such user interfaces. The challenge addressed through this research was to provide principles and guidelines to enable the design of operational interfaces that influence and support improved user-product interaction.

Domestic information-processing appliances need to be designed to be both usable and used by older adults. The goal of this research was to enable older adults to have self-supported and fulfilled lives for longer, through the design of improved operational interfaces. In the future, this changing norm within society, from serving younger to older markets, will demand a change in the focus of products designed for older adults: from functional and technical operating systems to operational interfaces designed for people with reduced capabilities.

Table 2.1 combines activities for daily living from the Nottingham Extended Activities of Daily Living scale Nouri et al. (1987) with capabilities from the Cambridge Inclusive Design Cube Keates et al. *(*2004) adapted by Holt (2007). The matrix in Table 2.1 was used to frame the research study in the context of the activities of daily living.

Table 2.1 Nottingham Extended Activities of Daily Living Scale and the Cambridge Inclusive Design Cube adapted from Holt (2007)

Capabilities Required [from Cambridge Inclusive Design Cube] / **Activities of Daily Living** [from Nottingham Extended Activities of Daily Living scale]	**Motion Capabilities**			**Sensory Capabilities**		**Cognitive Capabilities**		
	Locomotion	**Reach & Stretch**	**Dexterity**	**Vision**	**Hearing**	**Communication**	**Intellectual functioning**	**SOCIAL ASPECTS**
MOBILITY								
Walk around outside								
Climb stairs								
Get in and out of the car								
Walk over uneven ground								
Cross roads								
Travel on public transport								
IN THE KITCHEN								
Feed yourself								
Make yourself a hot drink								
Take hot drinks from one room to another								
Do the washing up								
Make yourself a hot snack								
DOMESTIC TASKS								
Vacuum cleaning								
Wash small items of clothing in a washing machine		**X**	**X**	**X**	**X**	**X**	**X**	
Do your own shopping								
Do a full clothes wash		**X**	**X**	**X**	**X**	**X**	**X**	
Cooking a meal		**X**	**X**	**X**	**X**	**X**	**X**	
Heating a ready meal in a microwave oven appliance		**X**	**X**	**X**	**X**	**X**	**X**	
LEISURE ACTIVITIES								
Read newspapers and books								
Use the telephone								
Write letters								
Go out socially								

Table 2.1 shows older adults' capabilities investigated in this research study and includes: reach and stretch, dexterity, vision hearing, communication and intellectual functioning. Locomotion and social aspects do not normally task an individuals' ability to conduct an operational procedure with an information-processing appliance.

Domestic information-processing appliances are predominantly operated through user-product interactions that include physical, cognitive and visual responses. Interactivity is managed with limited interactive resources such as menu selection, soft function keys and small displays. This interaction relies on the operator being able to perform tasks which involve good eye and hand co-ordination. Many older adults are currently unable to use visual instructions and directions on the displays and controls of domestic information-processing appliances, because interaction paradigms do not match visual and cognitive processing levels of older adults.

As people age, they go through a number of physiological and cognitive changes. Taking these changes into account might enhance product usability and increase product interaction qualities for all consumers. In the past, attempts to create appliances that are both technically sound and functional, has resulted in products which are not always universally applicable to needs and requirements of people who are less physically, cognitively, and visually able. Redstrom (2006) argues that, when designing displays and controls on appliances, their association with either an activity or an operational procedure should be prioritised over styling and aesthetics.

The design of operational interfaces which are based on an understanding of the determinants which effect usability, such as information-processing skills of individuals and technology are likely to be more general than products for older adults with specific disorders. Currently, practical product design guidance on how to address reduced capabilities is lacking, however, matrices that combine activities for daily living Nouri et al. (1987) with reduced capabilities Keates et al. (2004) are being used increasingly to frame research.

2.2 Older Adults & Their Use of Domestic Appliances

As the world's ageing population living independently increases, research will become more concerned with the design of domestic information appliances used by older adults in the home Ficocelli et al. (2012). Higgins & Glasgow (2012) identifies the significance of domestic information-processing appliances to older adults in the activities of daily living. They observe that older adults' ability to use domestic information-processing appliances depends on three closely linked factors: operational interface designs; categories of information; and operations on the appliance. Their study shows the relevance of links between information, operational interface design and operational sequences to older adults. They observe that older adults refer to similar pieces of information and operational interface features on similar appliances.

Mustaquim (2015) evaluates the strengths and weaknesses of operational interface designs. He identifies reasons why information designs on operational interfaces tend not to suit older adults. He suggests that

operational interface issues results from inconsistencies information on operational interfaces. He points out that information inconsistency is major a concern to older adults. There is a significant body of research to suggest that good operational interface design is obtainable. Johnson et al. (2012) argue that understanding older adults' abilities, needs and expectations is key to providing them with adequate instructions and direction on operational interfaces. Ghayas (2013) observes older adults using features such as symbols, images, text, icons and lettering. He argues that visual instructions are vital for older adults' perceptions of usefulness of product characteristics.

Bruder et al. (2014) argue that a large number of operational interfaces are now part of older adults' everyday lives. Moreover, older adults learn to use operational interfaces by trial and error. Their study observes older adults with little experience using new operational interfaces. They draw the conclusion that older adults 'struggle' to use everyday operational interfaces. Bruder et al. (2014) argue that studies which document older adults' use of everyday operational interfaces in the home are small in number. Elton et al. (2013) concur with Bruder et al. (2014), however, they argue that studies which do consider older adults' use of everyday operational interfaces focus the attention on older adults' abilities, rather than taking into account the task conditions. A study carried out a decade before Elton et al. (2013), by Huppert (2003) identifies five user characteristics affected by task conditions: perception, working memory, cognitive load, work load and concentration.

Hurtienne et al. (2013) show why it is relevant to identify the effects of task conditions on older adults' abilities. They argue that it provides a context for

assessing human activity, thus, presenting a true assessment older adults' abilities. Their study observes older adults experiencing ill-defined and inconsistent task conditions. They suggests that task conditions are, in part, a major reason why older adults' experience difficulties when operating appliances. Hurtienne et al. (2013) draw attention to older adults' processing abilities, or lack of it, and the wider range of information-processing activities needed to use operational interfaces on domestic information-processing appliances. Central to their argument are insights on the differences between cognitive operational interface issues experienced by older adults.

Studies which focus on older adults' operational interface issues tend to emphasise the needs for: tactile interface design Calypoole et al. (2016); interactivity Duh et al. (2016); operational system design Mayer et al. (2016); usability testing Castro et al. (2015); service design Coelho et al. (2013); and co-design methods Mitzner et al. (2016). Newell et al. (2007) argue that evaluations of operational interfaces on domestic information-processing appliances with older adults are variable. They argue that studies present data collection methods which fail to interpret older adult's interactions, processes and activities. They suggest that observations of older adults' in accordance with these factors present methodological challenges and opportunities for user-centred design. One significant challenge is identifying the variances in ageing and age-related decline.

Identifying heterogeneity in the ageing process presents design challenges and opportunities for product designers Kawamoto (2013). Studies suggest that there is diversity of older adults' attention levels, concentration, perceptual load, cognitive load and word comprehension Yen (2013). Dah

(2016) argues that there is a misunderstanding of heterogeneity in the ageing process. He points out that this is only one way to explain the inadequacies of operational interfaces for older adults. He suggests that older adults are disadvantaged by operational interface designs that focus on frailty and diseases, rather than the transitional process of ageing. Clay & Barrel (2013) show that on many occasions operational interface designs for older adults are based on misleading stereotypes and unfounded indicators of the ageing process. Peter (2010) observes older adults using products and suggests that older adults, like products, have personalities and characteristics of interactions. Furthermore, Atkinson et al. (2010) suggest that definitions of these characteristics of interactions are needed to specify design requirements for operational interfaces for older adults. Their study is particularly interesting, because they argue that there are significant differences in older adults' behaviours, processes, activities, actions and operations when they experience difficulties using operational interfaces.

2.3 Review of Standards & User Centred Design Guidelines

This sections sets out the key international standards in the area of user-centred design, however, many of the standards have coverage of design for reduced capabilities. The main body of standards in this area are those produced by the International Organization for Standardization (ISO). In addition to standards, there are a large number of user centred design guidelines that have been published by individuals and organisations. When designing a domestic information-processing appliance it can be worth consulting these types of guidelines . There are also guidelines that provide

recommendations concerning usability of different types of products, systems and services for users with disabilities.

Standards and user centred design guidelines can be divided up into four main categories.

- Understanding accessibility issues.
- Understanding system issues.
- Describing end user requirements and defining desirable properties of products.
- Re-engineering existing designs by redeveloping or adapting elements.

The standards and user centred design guidelines shown in Table 2.2 set out requirements. Few provide an understanding of the human activities when performing a task with a domestic information-processing appliance, the context of use, operational user interaction, or instructional material characteristics. Table 2.2 shows the sources used. Standards and guidelines tend to be limited to classifications and guidance in four areas: understanding, engineering, re-engineering and describing operational interfaces.

Table 2.2 (a) Sources used for the Review of Standards & User Centred Design Guidelines

British Standards & European Legal Frameworks	Source	Brief description of use
The Inclusive Design Toolkit Clark (2000) http://www.inclusivedesigntoolkit.com/betterdesign2/	A tool for understanding customer diversity to design better mainstream products	**Understanding accessibility issues**
Heuristics of Usability Nielsen (1995) http://www.nngroup.com/articles/ten-usability-heuristics/	Ten general principles for interaction design	**Understanding accessibility issues**
System Usability Scale http://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html	A tool for measuring the usability of domestic information-processing appliances	**Describing end user requirements and defining desirable properties of products**
Activity – Centred Design: An Ecological Approach to Designing Smart Tools and Usable Systems (Acting with Technology) Gay & Hembrooke (2004)	Ecological Approach to Designing	**Describing end user requirements and defining desirable properties of products**
The Design of Everyday Things Norman (2013)	Product Usability Guidelines	**Describing end user requirements and defining desirable properties of products**

Table 2.2 (b) Sources used for a Review of Standards & Guidelines

British Standards & European Legal Frameworks	Source	Brief description of use
ISO-IEC Guide 71:2014 - Guide for Addressing Accessibility in Standards	A guide with information about Understandability in Clause 6.2.6	**Understanding accessibility issues** .
ISO-IEC Guide 71:2014 - Guide for Addressing Accessibility in Standards	A guide with information about People in Clause 7 and Terminology in Clause B	**Describing end user requirements and defining desirable properties of products**
ISO 9241-210:2010 - Ergonomics of human-system interaction – Part 210:	Human-centred design for interactive systems - the international standard on designing human-centred systems	**Re-engineering existing designs by redeveloping or adapting elements**
PAS 1365:2015 - Codes of practice for the recognition of dementia-friendly communities in England	Recommendations for how to develop a dementia-friendly community	**Describing end user requirements and defining desirable properties of products**
DD ISO/PAS 18152:2003 - Ergonomics of human-system interaction	Specification for the process of assessment of human-system issues	**Understanding system issues**
ISO/TR 16982:2002 - Ed 1 Ergonomics of human-system interaction	Usability methods supporting human-centred design	**Engineering or designing new systems of product part by redeveloping or adapting interaction techniques**
BS EN 301549:2015 - Accessibility requirements suitable for public procurement of ICT products and services in Europe	An overview of Mandate M 376 & Mandate M 473 - describes the requirements for software accessibility defined in EN 301 549 and includes 'Design for All' in relevant standardization initiatives according to a feature-based approach	**Describing end user requirements and defining desirable properties of products**
PP 7310:1990 - Anthropometrics: An introduction	Anatomical configurations, Human body, Size, Ergonomics and Anthropometric characteristics	**Re-engineering existing designs by redeveloping or adapting elements**
The 7 Principles and 29 Guidelines for Universal Design http://universaldesign.ie/What-is-Universal-Design/The-7-Principles/	Guidelines on balanced design selection criteria	**Describing end user requirements and defining desirable properties of products**
Universal Design – Product Evaluation Countdown http://www.ncsu.edu/ncsu/design/cud/pubs_p/docs/UDPEC.pdf	A tool for rating a product on a Likart Scale – (Universal Design in reverse order)	**Describing end user requirements and defining desirable properties of products**

Publications and tools such as the code of practice for the recognition of dementia-friendly communities in England (PAS 1365:2015) and the inclusive design toolkit Clark (2000), give guidance and recommendations on how to assess older adults' interactions and information-processing activities using operational interfaces on domestic information processing appliances. Although there are guidelines for designing user interfaces for older adults available online, they are general in nature and not explicitly related to the functionalities of specific domestic appliances such as microwave ovens and washing machines. Moreover, there is limited guidance for assessing and testing the usability of microwave oven and washing machine operational interfaces. Furthermore, fewer publications provide tools or methods for the assessment of older adults' interactions and information-processing activities. The majority of publications tend to focus on older adults' physical capabilities rather than their intellectual or information-processing capabilities.

2.4 How Older Adults Use Operational Interfaces

Rogers et al. (2005) argue that operational interface design solutions focus mainly on ergonomic design. Brajnik (2014) evaluates the strengths and weaknesses of several operational interface experience models. Their study describes how to implement certain ergonomic design factors for older adults. However, Malinowsky et al. (2010) argues that to resolve operational interface issues, studies should consider how older adults use operational interfaces.

Rodriguez (2012) argues that product designers should consider interactions and information-processing activities to understand all aspects of user-

product interactions. They argue that product designers devote attention to design solutions that compensate for specific sensory, motor and visual difficulties related to the ageing process**.** Furthermore, he suggests that if the needs of older adult are to be met, older adults' information-processing abilities and activities need to be identified.

(Frohlich et al. 2012a & 2012b) and Frohlich et al. (2013) argue that subjective difficulties reported by older adults tend not be adequately documented in research studies. Lim et al. (2012) shows the relevance of subjective difficulties to levels of reported operational interface issues. They argue that the ways in which older adults learn about operational interfaces differ. They suggest that older adults' ease of learning how to use operational interfaces is due, in part, to experiences with technology. Frohlich et al. (2012) argue that older adults understandably make adjustments in process when learning about operational interfaces or faced with operational interface difficulties. Their study observes that adjustments in older adults' processes are important for information-processing. Sonderegger et al. (2016) argue that time duration and speed of adjustments are indications of older adults' processing abilities.

Sengpiel (2011a) argues that operational interfaces in the home present challenges for older adults and opportunities for product designers. Imai et al. (2010) disagrees with Sengpiel (2011b), however, they argue that in recent years additional and unnecessary features on operational interfaces have been added. They observe that operational interfaces are changed, revamped or renewed annually for the same model of appliances. They identify that these additional features on operational interfaces cause major

operational interface issues for older adults. Imai et al. (2010) argue that older adults struggle to use new and ever changing operational interface designs.

Shi & Setchi (2012) observe the effects of these operational interface features on older adults' interactions and information-processing abilities. They argue that older adults' information-processing and interactions could provide an understanding of improved design requirements. de Barros's (2014) concluded that older adults' experienced difficulties when interacting with operational interfaces. He argues that operational interfaces incorporate advanced information and communication technologies far beyond what is needed for everyday use. Rose et al. (2010) observe that when faced with challenging operational interfaces older adults increase their rate and readiness to use compensatory strategies. Their study identifies that older adults 'improvise' and seek 'interventions' when operational interface issues occur. Kawamoto et al. (2014) argues that advancements in technology have allowed the emergence of new operational interfaces, however, these non-conventional operational interfaces conflict with older adults' natural processes.

Finucane (2010) observes variances in older adults' processing which affects their ability to use task-specific knowledge. He shows that the decision-making competences of older adults are impaired by operational interfaces. Mitzner et al. (2016) argue that information access is, in part, the main cause of older adults' slow adoption of digital technologies. They give reasons for their conclusions, stating that perceptions about its usefulness are poor. According to Mitchell et al. (2013) older adults tend to monitor the

information required to discern the task. Boman et al. (2012) and Ghayas et al. (2013) identify mismatches between information and operations. Mitchell et al. (2010) identify that irrelevant information is more likely to affect older adults' information-processing abilities. However, they suggest that there is uncertainty about how older adults use information (irrelevant or relevant) to inform the task. They observe that older adults fail to recognise, understand, interpret and make connections between instructional information on operational interfaces. Old & Naveh-Benjamin (2008) and Old & Naveh-Benjamin (2012) concur with Mitchell et al. (2010), however, they argue that there is a disconnection between the information and its meaning in a real world context. Moreover, their study shows that information designs negatively affects older adults' information-processing ability this, in turn, affects interactions. One shortfall of their study is that they fail to specify the different sources of information which are attributes to information-processing and interaction difficulties.

Black & Burr (1996) evaluate design weaknesses of domestic information-processing appliances. They suggest that operational interfaces on domestic information-processing appliances should be more flexible and less 'concrete' and 'solid'. They argue that 'concrete' and 'solid' operational interfaces do not facilitate users' information-processing needs. One theory, proposed by Zajicek (2004) is that operational interfaces on washing machines and microwave ovens are not suited to the wider range of information-processing strategies used by older adults. Ferreira et al. (2014) argue that the successful use of operational interfaces depends on the careful selection of adaptable operational interface features.

Bodker (1987), Bodker (1989), Bodker (1995), Bodker (2006) and Bodker & Sundblad (2008) describe three categories of operational interface features: physical aspects, handling aspects and information aspects. Unlike other studies, their study provides a method for describing users' interactions with operational interfaces on domestic information-processing appliances. Bodker et al. (2008) suggest that when operational interface issues occur, these categories can be used to explain how older adults use operational interfaces when subconscious actions become conscious activity. Winograd & Flores (1986) refer to the behaviours as 'interaction breakdowns' and 'focus-shifts'. Langdon & Thimbleby (2010) argue that characterising the user–product relationship has the potential to improve operational interfaces. Lockton et al. (2010) go further, suggesting that operational interfaces influence older adults' behaviours positively if they provide guidance on operational procedures.

Brewster et al. (1994) identify the effects of operational interfaces which give little guidance. They observe how users interact with poor operational interface; continuously moving between operational interface features. They describe these behaviours as 'kangarooing'. Lockton et al. (2010) argue that older adults exert a large amount of effort and time in the behaviours in endeavours to search for the most appropriate operational interface features. Norman (2013) attributes the behaviours to ill-defined operational interface design layouts. Newell et al. (2007) suggest that product designers should develop empathy for older users to resolve these issues. Kaptelinin & Nardi (2006) and Kaptelinin (1996) concur with Norman (2013) and Newell et al. (2007), however, they argue that product designers must develop an

understanding of how older adults use operational interfaces to conduct an information-processing activity. Their study shows ways in which older adults' activities are improved by understanding their design requirements.

Riedl et al. (2012) argue that despite all that is known about improving operational interfaces for older adults, they still present older adults with impediments to workflow activity. Johnson et al. (2010) argue that these impediments increase older adults' stress levels which, in turn, impacts on performance. Old & Naveh-Benjamin (2012) and Old & Naveh-Benjamin (2008) suggest older adults' pre-learned actions, operations and activities should be studies to improve operational interfaces. Their study shows the merit of making connections between operational interface features and operational sequences used in the real world. Both studies weigh up the importance of operational interfaces which presents operational sequences used in older adults' real life experiences. Moreover, it is Old & Naveh-Benjamin (2008) study that emphasises the opportunities which lies in building links between human activities, operational sequences and operational interface design.

2.5 Designing Operational Interfaces for Domestic Information Processing Appliances

All users benefit from information presented simply and clearly. Duh (2016) argues that the premise that designing domestic information processing appliances for older adults could become a costly expense is a misapprehension. Joe et al's (2015) study shows that operational interfaces for older adults do not always result in multiple operational interface designs

with variability in information design. Their study identifies that information design on operational interfaces has becomes increasingly popular, however, they argue that the information on operational interfaces tend not to be formally tested to assess its usability. They point out that traditional rigorous methods used for the analysis and evaluation of operational interfaces such as inclusive design methods, user centred design methods and human centred design methods takes a significant amount of time to implement. Park (2011) shows the relevance of good information design. His study shows that tacit and explicit knowledge derived from older adults' operational series can be used to improve information design on operational interfaces. Davenport et al. (2012), Nygard et al.(2012) and Boman et al. (2012) argue that operational sequences in a real world context is often overlooked as a way to categories operational interface features and procedures. Shi & Setchi (2012) point out that the archetype of older adults operational sequences is based on older adults' background knowledge, memory and experience.

Rodríguez (2012) argues that product designers should ensure that the cognitive needs and aspirations of older adults are taken into consideration. He argues that additional cognitive assessment methods should be used to establish operational interfaces for older adults. Clarkson & Coleman (2015) concur with Rodríguez (2012), however, they argue that to achieve success in activities of independent living, product designers require new approaches to designing domestic information processing appliances. Coelho et al. (2013) point out that designing a domestic information-processing appliance

differs from designing traditional desktop or web applications because of the distinct context surrounding their use.

Joe et al. (2015) suggest that tools and frameworks to evaluate operational interfaces, in the context of activities of daily living, are few in number. Lin et al. (2016) identify the need for tools and methods to develop context specific operational interfaces. National Eye Institute (2008) and Charles (2007) identify two context specific areas for improvement: reading and information recognition. Pieter (2008) observes domestic information-processing appliances in use and suggests that design tends not to offer older adults affordances to facilitate reading and information recognition. Moreover, the information tends not to be presented in clear operational sequence. Cronin-Golomb et al. (2007) identify spatial reasoning as a key aspect of older adults' reading and information recognition abilities. Polat et al. (2003) identify that colour and contrast could be advantageous to older adults to facilitate classifying, categorising and recognition of information. Ganneau et al. (2008) identify that older adults require information which is presented in lists.

Studies describe principles for improving the performance of appliances such as microwave ovens Fan et al. (2012). However, a limited number of studies describe design principles for good operational interface design for domestic information-processing appliances such as microwave ovens and washing machines. Mugge & Schoormans (2012a) argue that there is a lack of verification of operational interface designs on these types of kitchen appliances, and that consumers are more likely to view new and novel operational interfaces as good operational interfaces. Their study points out

that those consumers perceive newness and novelty of operational interface design as an indicator of the appliances' high levels of technological performance and innovation. Hutchison et al. (1997) argue that novelty is neither required nor desired by older adults. In fact, they suggest that as more emphasis is placed on technological advancement, older adults find the application 'awkward' and 'confusing' to use. Rafferty et al. (2015) argue that adopting a more rigid approach to the selection of operational interface features has the potential to address these types of operational interface issues.

Branjnki et al's (2014) study shows that a framework that encompasses several user experience characteristics has the potential to describe how certain design factors affect older adults' experiences. However, Kaptelinin & Nadi (2006) and Kaptelinin (1996) argue that frameworks of user experience characteristics fail to identify why interruptions to users' workflow activity occur. Bodker (1987), Bodker (1989) and Bodker (2008) argue that evaluations of human activity provide an opportunity for the development of a coding scheme which connects users' actions, activities and operations. Lockton et al. (2010) argue that the benefit of a coding scheme lies in its ability to code older adults' activities and goals. Rose et al. (2010) point out that analytical and descriptive frameworks lack distinctive quantitative data. Joe et al. (2015) identify the potential that lies in the evaluation of older adults' think-aloud data. Finucane (2010) observe that older adults' think-aloud data can be used to identify events and episodes in interaction and information-processing activities that warrant further exploration. He explains that a coding scheme could provide insights on older adults' information-

processing acquisition behaviours. Carmichael et al. (2007) show that the identification of older adults' interactions and information-processing activities requires a combination of methods: a coding scheme with analytical and descriptive codes and video-recordings of observations. Their study suggests that combining methods has the potential to give new insights on the differences of older adults' interactions and information-processing activities.

Newell et al. (2007) and Zajicak (2004) argue that methodologies for involving older adults' information-processing activities and interactions are inadequate. There are several examples of systematic coding schemes for evaluations information-processing acquisition behaviours Arunachalam & Sasso (1996), Atman et al. (1999), Ateca-Amestoy & Ugidos's (2013) and Hughes & Parkes (2003). Few studies consider older adults' interactions and information-processing activities using operational interfaces on domestic-information-processing appliances. Ateca-Amestoy & Ugidos's (2013) describe the multidimensional, complex combination of physical and psychological challenges, skills levels, achievement threshold, concentration level, and working memory used by participants' to process and acquire information. Their study shows that quantifiable description of user-product interactions demands the capture of verbal and non-verbal data.

Mitchell et al. (2013) identify the significance of capturing older adults' verbal and non-verbal data when studying older adults' attention. They argue that older adults' selective attention (reacting to certain visual or auditory information) is affected by the ability to perceive or ignore stimuli such as visual or auditory information. Mitchell et al. (2010) argue that studies tend

not to focus on ‘disruptive sources’ which affect selective attention. Van der Wardt et al. (2012) concurs with Mitchell et al. (2010), however, they conclude that there is a relationship between process, acquiring information and selective attention. Bryman & Cramer (2002) identifies that an analysis of the language used in task interpretations could provide patterns and themes of theoretical importance. Borsch-Supan (2013) indicates that an analysis of language used in task interpretations has the potential to identify subtle changes and variations in adjustment behaviours. Mitchell et al’s (2010) and Young et al. (2012) argue that fewer studies quantify these relationships in relation to heterogeneity in older adults. However, neither author’s highlights its importance to the design of operational interfaces on domestic information-processing appliances.

2.6 Summary

The purpose of the literature review carried out as part of this research was to provide an understanding of the changing needs of older adults. Conclusions were used to determine ways in which the design of operational interfaces for older adult could be improved. The literature review concludes that there are a limited number of user centred design research studies that studied older adults’ selective and perceptual attention, concentration, perceptual load, cognitive load and word comprehension. In addition, inclusive and user centred design studies devote attention to designs that compensates for specific sensory, motor and visual difficulties related to the ageing process.

The picture emerging from the literature is summarised through the following points.

- In activities of daily living, information-processing is an aspect of interactions with domestic information-processing appliances.
- Older adults experience difficulties with operational interfaces on domestic information-processing appliances.
- Older adults devise compensatory strategies to cope with experienced difficulties.
- Older adults depend on good information design on operational interfaces.
- Current operational interfaces fails to support the needs of diverse older adults.
- Little has changed in terms of approaches to design and development of domestic information-processing appliances.

The literature review emphasises the first steps needed to design improved operational interfaces for older adults. Opportunity lies in the development of a coding scheme to collect data for analysis on older adults' interactions and information-processing activities. The benefit lies in the definition of user-interactions and information-processing activities. These research studies will assess older adults' behaviours, intentions and activities using domestic information-processing appliances. In this research study, information used in the task is of interest.

The thesis argues that coding schemes tend not to translate older adults' real-world experiences using domestic information-processing appliances.

Moreover, the information used in the task is the main cause of older adults' inability to successfully complete operations with the appliance. The coding scheme will be used to: code the use of information; and identify contradictions observed in older adults' operation sequences, activities or actions. In addition, a coding scheme will describe older adults' information-processing activities and interactions. Developing a coding scheme from empirical studies is an outcome of this research study. The research methodology used to define the coding scheme (data collection and analysis tool) is described in Chapter 3.

Chapter 3
Methodology

The purpose of this chapter is to explain the methodological approach used in this research. After an initial description of the methodological framework, an explanation of the research case studies is provided. Following this, a description of the participants and case studies are given. Combinations of participants, case studies and research instruments are outlined. In addition, case study appliances, associated instructional materials and other resources are presented. Finally, a description of the research process is outlined.

3.1 Methodological Framework

Studies have shown that older adults' abilities to use domestic appliances depend on three closely linked factors: operational interface design, visual information, and clear sequential operations on appliance user interfaces Higgins & Glasgow (2012). Evaluations of older adults' abilities, more often than not, focus on tactile interface design elements, levels of user interface interactivity and menu design facilitated by usability testing. This has resulted in studies focused on older adults' abilities, or lack of abilities, rather than a consideration of the task conditions and human activities. Information inconsistency is a major concern to older adults. (Frohlich et al. 2012a, 2012b & 2013) argue that user interface designs need to reflect an overarching process where the usage process provides context for actions, operations and activities. Providing adequate instructions and directions is key to improved interactions, specifically categories and features on user

interfaces aimed at improving support for older adults understanding information conveyed across all forms of instructional materials.

Information accessibility and inconsistency are potential barriers to improving older adults' interactions and information-processing. Differences in the ways in which older adults' behave using domestic appliances fail to recognise the diverse use context in human activity. Rose et al. (2010) observe that when faced with challenging operational situations, older adults when compared with younger adults the increase use of compensatory strategies. Rose et al. (2010) provide insights into older adults' subjective experiences suggesting that older adults improvise and seek interventions when faced with operational difficulties. One shortfall of the study is that it fails to specify the various conceptual elements in relation to information used by older adults during improvisation and intervention episodes. For example, the study does not take account of participants' previous experiences in using domestic appliances which lead to pre-learned actions, operations and activities when using new domestic appliances in purposeful context.

Disconnections between information sources and their meaning in a real world contexts has negatively affected older adults' information-processing ability and, in turn, interactions. Furthermore, Jones & Sarter (2008) emphasise the importance of identifying and linking human activities to operational sequences and user interface design suggested by Rose et al. (2010). Current data collection methods fail to interpret interactions, process and activities. Moreover, Old & Naveh-Benjamin (2008) and (2012) suggest that older adults' information-processing abilities and activities need to be

identified to align with the use of inconsistent information provided by multiple sources, e.g., washing instructions and labelling on clothing. On occasions there are mismatches between information and purpose, in the context of the specified human activity Boman et al. (2012). Variance in older adults' information-processing and task-specific knowledge affects decision-making competences. Their study suggests that older adults tend to monitor the information required to discern the tasks' purpose. This suggests that there is uncertainty in the ways that older adults use information irrelevant or relevant to inform performance in task.

This research explored information-processing activities and interactions amongst older adults through an investigation of older adults' experiences and perceptions of information-processing activities and interactions when operating domestic information-processing appliances. Including the factors which inform operations such as information source materials such as operational user interfaces, manuals, and additional information source materials. Naturalistic inquiry case study methods were used to focus on participants' actions, activities and goals. Sonderegger et al. (2016) argue that time duration and speeds of adjustments are quantifiable indications of older adults' processing abilities. These thematic qualitative data analysis methods were used to identify and describe characteristics of human activity and user- product interactions. The following aspects of human activity and user- product interactions were considered physical, handling and visual instructions.

- Physical aspects: related to the form and overall shape of the physical appliance.

- Handling aspects: related to features and elements to be operated by the hand such as switches, plugs, buttons, and control knobs.
- Visual instructions such as text, symbols, images, icon representation, and lettering on the appliance or the instructional materials.

Participants' verbal protocol and protocol traces using the microwave oven were coded and analysed. The following five criteria were used to analyse participants' interactions, information-processing and interruptions to workflow with the microwave oven, washing machine and information source materials.

- The mean time spent in information-processing activities.
- The mean time spent in interaction activities.
- The mean time spent in impediments to workflow.
- Duration of time spent in multiple information-processing activities.
- Duration of time spent in multiple interactions.

The methodological framework was devised to look for the existence of constant relationships between events of interaction breakdowns and focus-shifts. Blaikie (2000) study of positivism provided methods to make sense of discrete and observable events. Research methods were brought together to enable the identification of interaction breakdowns and focus shifts through deductive reasoning. Learning from this process was used to develop a categorisation scheme for information-processing activities, interactions and impediments to workflow which, in turn, was used to inform the development of a coding scheme for use in the design of operational interfaces for older adults.

The research brought together a number of descriptive and experimental research methods. Key stages in the research process are summarised in Figure 3.1. It shows the four key stages in the research methodology. In the next section, each stage of the research methodology is described in detail. Prior to commencing the main research study, ethical clearance was sought from the Chair of the MaPS and Engineering Joint Faculty Research Ethics Committee (See Appendix B).

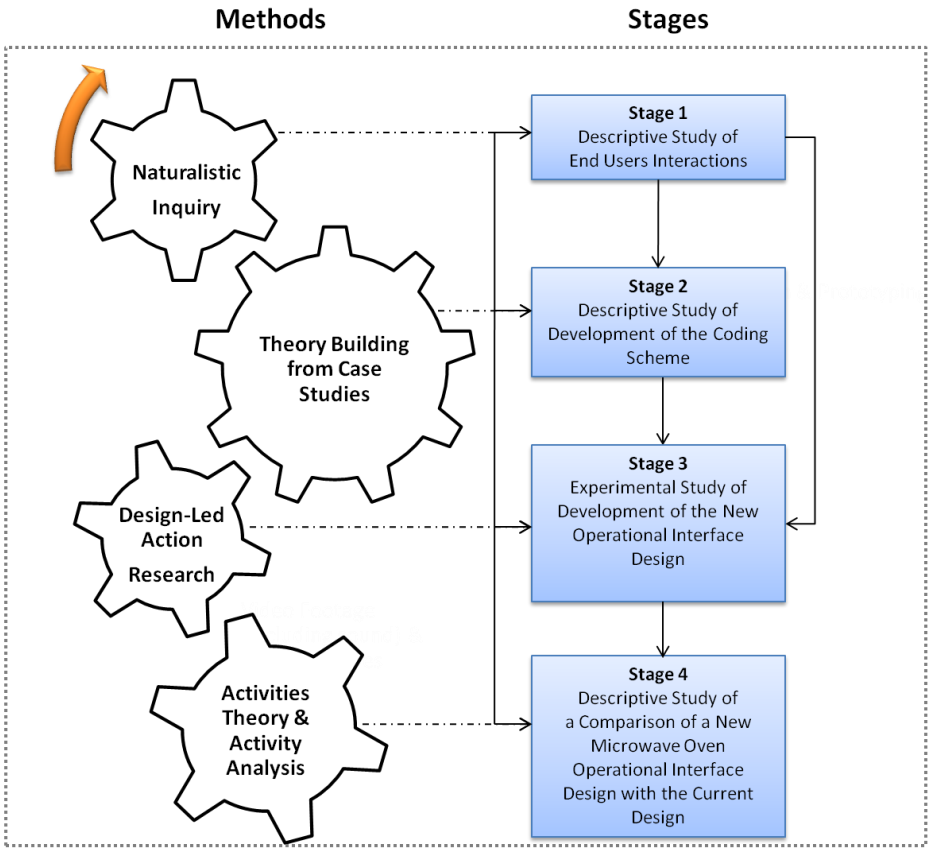


Figure 3.1 Key Stages in the Research Methodology

3.1.1 Stage 1: Descriptive Study of End User Interactions

In Stage 1, the descriptive case study built on the literature. Two empirical studies with two participants, one using a washing machine and the other using a microwave oven were carried out. Naturalistic inquiry methods described by Lincoln & Guba (1985) were used to identify operational interface design goals, through observations of older adults using operational interfaces on domestic information-processing appliances. Each participant was asked to carry out an activity of daily living: wash laundry using a washing machine; and heat a ready meal using a microwave oven. Participants were asked to interact and talk-aloud. Data was video-recorded and transcribed using methods described by Ericsson & Simon (1998), Bodker (1995) and Suchman & Trigg (1991). Participants' characteristics of interactions using the microwave oven and the washing machine were identified. Evaluative performance criteria were derived. These were used as the driver for the new operational interface design derived in Stage 3.

3.1.2 Stage 2: Descriptive Study of Development of the Coding Scheme

In Stage 2, the descriptive case study used video footage of the participant using the microwave oven to derive the coding scheme. Data from Stage 1 was analysed to establish a framework to enable the assessment of the interactions and information-processing activities. Descriptions of interaction breakdowns and focus-shifts described by Winograd & Flores (1986) and Engestrome (1987) and information-processing skills described by Anderson & Krathwohl (2001) were used to define the participant's interactions and information-processing activities.

Theory building methods described by Eisenhardt (1988) and Eisenhardt (1989) and Bourgeois & Eisenhardt (1989), and Carlile & Christensen (2004), in addition, thematic qualitative data analysis methods described by (Kings (2004) and Gibbs (2008) were used to identify codes and categories for interactions and information-processing activities. A coding scheme for use in the assessment of participants' interactions and information-processing activities was established. The coding scheme was used in Stage 4.

3.1.3 Stage 3: Experimental Study of Development of the New Operational Interface Design

In Stage 3, experimental case studies were used to derive an alternative operational interface design for use in the assessment of participants' interactions and information-processing activities. Design-led action research methods described by Fendt & Kaminska-Labbe (2011), van de Ven's (2007) and van de Ven's (2006) were used to derive a new microwave oven interface that facilitated participants' improved interactions and information processing activities. The new operational interface design was used in Stage 4.

3.1.4 Stage 4: Descriptive Study of a Comparison of a New Microwave Oven Operational Interface Design with the Current Design

In Stage 4, descriptive case study were used. Two empirical studies with eight participants, four using a new microwave oven interface and the others using a current microwave oven interface were carried out. Comparisons were made between participants using the two interfaces to assess participants' interactions and information-processing activities. Data was collected and analysed using the coding scheme. Case study methods

suggested by Carlile & Christensen (2004), Yin (1994) and Yin (2009) were used to compare data for empirical studies. Results were recorded in tables and figures.

3.2 Participants & Case Study

Thirty two participants initially agreed to take part in the usability studies. The sample required participants male and female aged between 65 and 75 years old. It was explained that participants would partake by carrying out a series of task activities with a variety of working commercial domestic consumer appliances, have their actions video recorded, and identify aspects of displays and controls which might cause user dissatisfaction. Thirty two participants arrived at initial workshops, thirty one were female one was male, but only nine agreed to be videotaped performing tasks with the case study interfaces.

Table 3.1 shows the age ranges of the twelve participants used in the overall research study. Case study participants' age ranged between 55 and 75 years-old. Age boundaries identified by Salthouse et al. (2003) and Richardson et al. (2012) were used to select older adults with natural age-related cognitive and physical decline. Methods used to recruit participants are given in (Appendix C). The instructional materials used in the study are also given in (Appendix D). In the research study, participants and case studies were used in various ways. Table 3.1 shows the ways in which participants, case studies and research instruments used in the research study.

Table 3.1 Participants, Case Studies & Research Instruments

Combinations of participant, appliance and interface used	Research Instruments	
Participants	**User interface**	**Instructional Materials**
(DH) Aged 67	Current microwave oven operational interface	Meal Packaging & Manual
(AD) Aged 68	Current microwave oven operational interface	Meal Packaging & Manual
(JB) Aged 72	Current microwave oven operational interface	Meal Packaging & Manual
(ST) Aged 74	Current microwave oven operational interface	Meal Packaging & Manual
(SL) Aged 65	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(CMK) Aged 69	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 70	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 74	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging

3.3 Combinations of Participants, Case Studies & Research Instruments

Table 3.2 shows combinations of case study, appliances and user interfaces used in the research study. Case study numbers were based on observational study methods described by Erlandson et al. (1993). Participant numbers were consistent with recommendations made by Erlandson et al. (1993).

Table 3.2 Combination of Participants, Case Studies & Research Instruments

Stage 1		
Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
GP (female) aged 55	Washing machine operational interface	Manual and clothing labels
MW (female) aged 68	Microwave operational interface	Manual and ready meal packaging
Fourteen responses to online feedback questions	Microwave operational interface	Manual
Stage 2		
Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
GP (female) aged 55	Washing machine operational interface	Manual and clothing labels
MW (female) aged 68	Microwave oven operational interface	Manual and ready meal packaging
Stage 3		
Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
VA (female) aged 61	Microwave oven operational interface	Manual and ready meal packaging
FG (female) aged 68		
TC (male) aged 58		
Stage 4		
Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
(DH) Aged 67	Current microwave oven operational interface	Meal Packaging & Manual
(AD) Aged 68	Current microwave oven operational interface	Meal Packaging & Manual
(JB) Aged 72	Current microwave oven operational interface	Meal Packaging & Manual
(ST) Aged 74	Current microwave oven operational interface	Meal Packaging & Manual
(SL) Aged 65	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(CMK) Aged 69	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 70	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 74	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging

3.4 Case Study Appliances, Associated Instructional Materials & Other Resources

Case study analysis was conducted through the human-machine loop model described by Pheasant (1986). Figure 3.2 illustrates the analysis methods used in each case study. It puts into context participants' activities, actions, operations and goals. Figure 3.2 shows the multi-modal activities, interactions and information-processing activities involved in the activities of daily living.

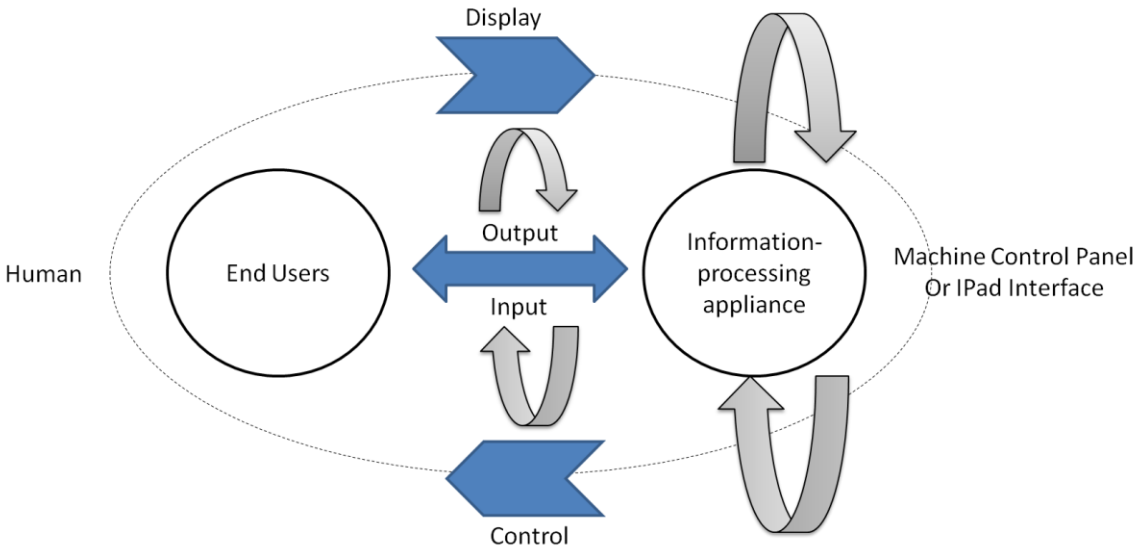


Figure 3.2 Structure of each Case Study Analysis using the Model of Human Machine Loop Adapted from Pheasant (1986)

Figure 3.3 illustrates the washing machine interface and its operational interface features. The appliance interface was analysed in Stages 1, 2 and 3. Figure 3.4 illustrates the microwave oven interface and its operational interface features. This appliance interface was analysed in Stages 1, 2, 3 and 4. Figure 3.5 illustrates the new microwave oven interface and its operational interface features derived in Stage 3. The new interface was analysed in Stages 4.

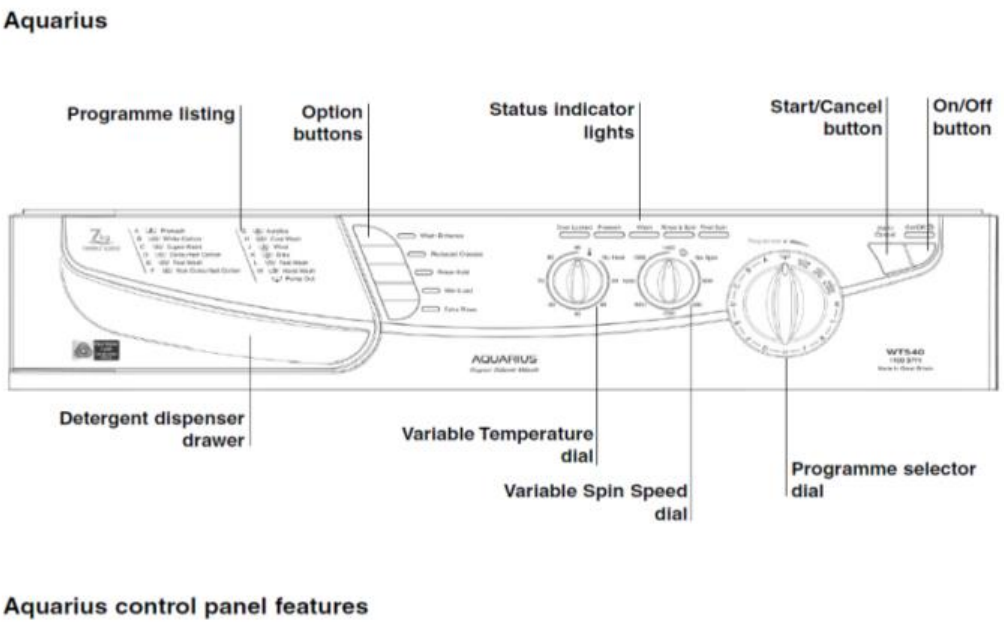
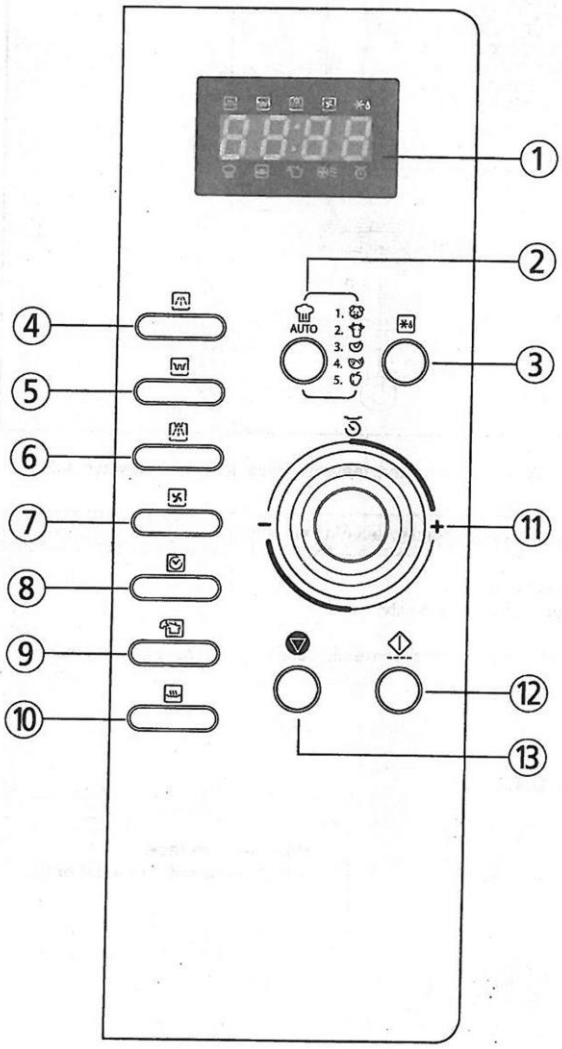


Figure 3.3 Washing Machine Operational Interface (used in Stage 1 2 & 3)



KOC-9Q3T7S

① **Display :** Cooking time, power level, program indicators and present time are displayed.
MW ( ): When blinking, the oven is operating in MICROWAVE COOK mode.
Grill ( ): When blinking, the oven is operating in GRILL mode.
Combi ( ): When blinking, the oven is operating in COMBI mode.
Convection ( ): When blinking, the oven is operating in CONVECTION mode.
Defrost ( ): When blinking, the oven is operating in DEFROST mode.
Auto-cook ( ): When blinking, the oven is operating in AUTO COOK mode.
Warm ( ): When blinking, the oven is operating in WARM mode.
Steam Cleaning ( ): When blinking, the oven is operating in STEAM CLEANING mode.
gram ( ): When blinking, the oven is operating in weight input mode.

② **Auto cook :** Used to cook or reheat.

③ **Defrost :** Used to defrost foods.

④ **MW :** Used to set power level of the microwave.

⑤ **Grill :** Used to select grill mode.

⑥ **Combi :** Used to select combi mode.

⑦ **Convection :** Used to select convection mode and selected temp.

⑧ **Clock :** Used to set clock.

⑨ **STEAM CLEANING :** Used to clean the inside of the oven

⑩ **Warm :** Used to keep the food warm.

⑪ **Dial knob :** Used to set time, weight and quantity.

⑫ **START/SPEEDY COOK :** Used to start a program or a speedy start(each press adds 30 seconds of microwave cooking time).

⑬ **STOP/CLEAR :** Used to stop the oven operation or to delete the cooking data.

Figure 3.4 Microwave Oven Operational Interface (used in Stage 1, 2, 3 & 4)

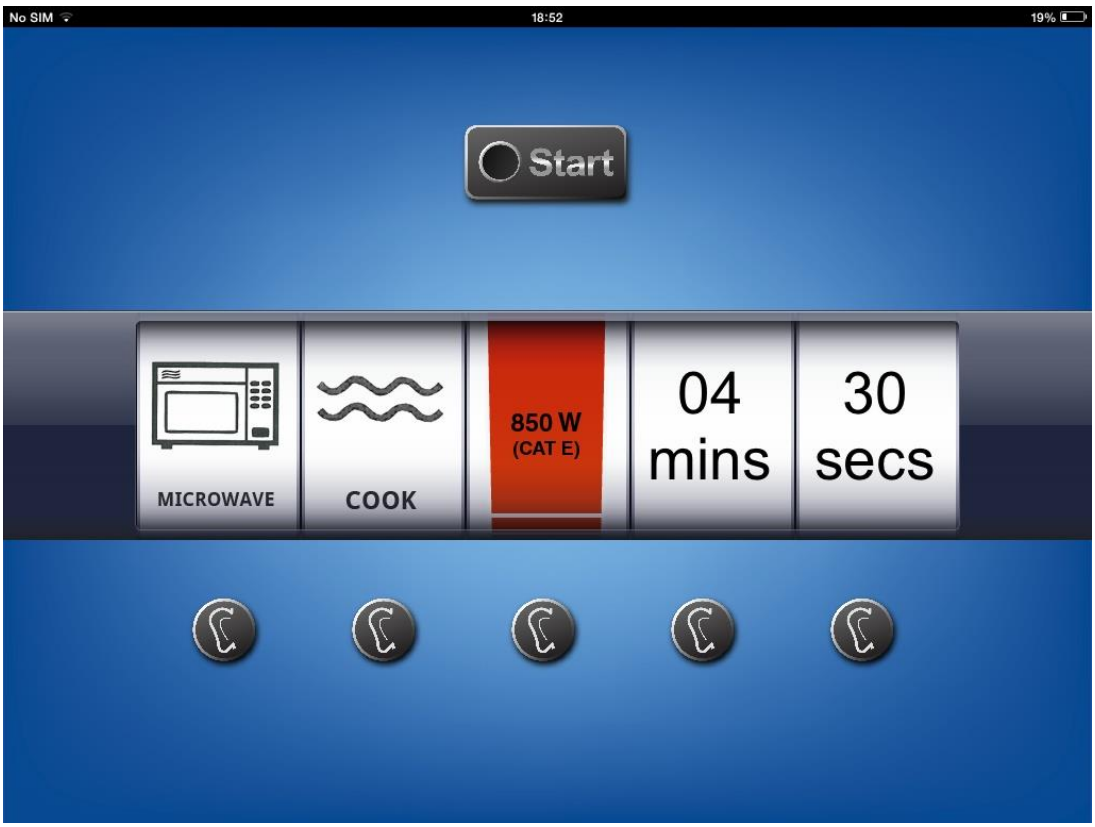


Figure 3.5 New Operational Interface Design of Microwave Oven Put Into An iPad app (used in Stage 4)

An example of the type of ready meal instructional materials used in the study is shown in Figure 3.6.

Figure 3.6 A convenience food ready meal labels and instructions used in the study.

3.5 Research Process

Figure 3.7 provides a summary of the research process used. Results are reported on in Chapters 4, 5 and 6.

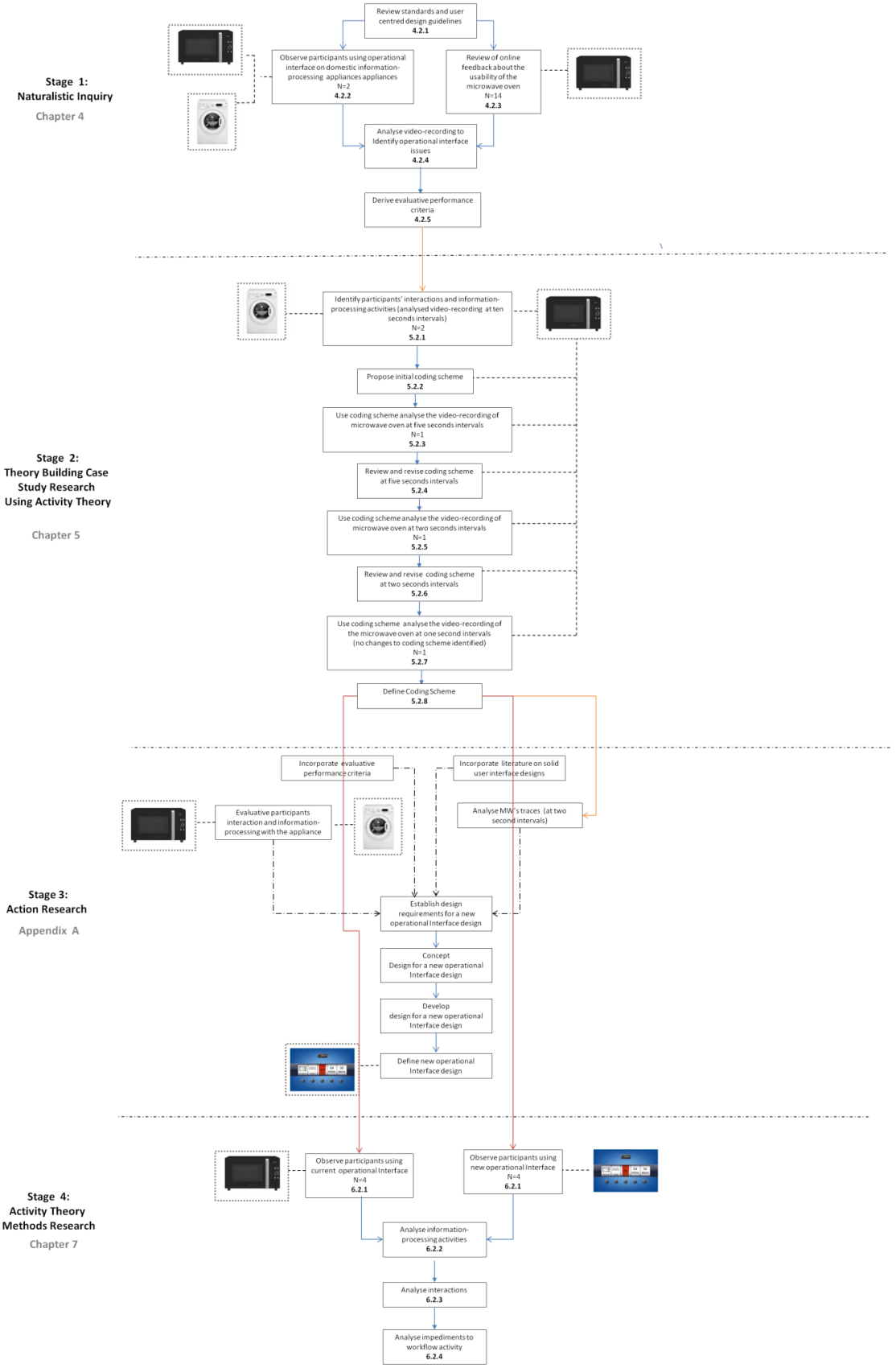


Figure 3.7 Summary of the Research Process

Chapter 4
End Users' Interactions

The aim of this chapter is to report on results of a study that used naturalistic inquiry methods. The study was conducted to provide insights on how two participants used operational interfaces on two domestic information-processing appliances. In this chapter, evaluative performance criteria are introduced. These criteria were used as the driver for the new operational interface design derived in Stage 3 (see Appendix A). Research instruments and participants in the experiments are summarised in Table 4.1. Section 4.1 gives an overview of the methods used in this study.

Table 4.1 Summary of Instruments & Participants in the Experiment

Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
GP (female) aged 55	Washing machine operational interface	Manual and clothing labels
MW (female) aged 68	Microwave operational interface	Manual and ready meal packaging
Fourteen responses to online feedback questions	Microwave operational interface	Manual

4.1 Method

Key aspects of the research process are shown in Figure 4.1.

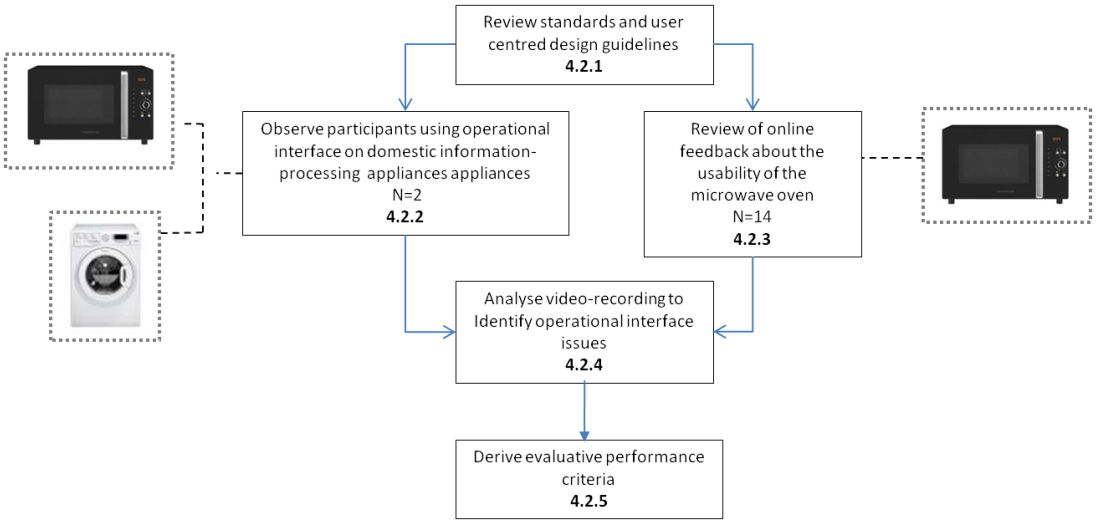


Figure 4.1 Process used to Identify Participants Interactions with Appliances

The research process built on the literature and case studies drawn from Lincoln & Guba (1985). Standards and user centred design guidelines were surveyed. They were selected, if they related to: designing for ageing populations; user interfaces; consumer and or digital devices for older adults. Key standards and guidelines were used to position the research study within the areas of inclusive design, user centred design and human centred design.

Naturalistic inquiry case studies were used to define the research scope. Two empirical case studies with two participants were conducted. The research instruments included a microwave oven and a washing machine

(see Table 4.1), and their associated instructional materials (see Appendix D). Participants were asked to heat a ready meal and to wash white cotton bedding. In addition, participants were asked to talking aloud. The tasks were video-recorded using methods described by Bodker (1995) and Suchman & Trigg (1991). Footage was analysed using verbal protocol analysis methods described by Ericsson & Simon (1998) to identify operational interface issues.

An online consumer feedback forum about the microwave oven was surveyed. Fourteen online consumer feedback responses about the appliance usability were identified. Responses were selected if they related to operational interface issues with the microwave oven. It should be noted that comparative consumer feedback on the washing machine was not available online. Responses were used to corroborate case study findings. Case study findings were used to derive evaluative performance criteria for the microwave oven and the washing machine. Findings are discussed in the next section.

4.2 Findings

Findings from the descriptive study are reported in this section using the structure and section numbers provided in Figure 4.1.

4.2.1 Observation of Participants Using the Microwave Oven

The study found three distinct participants' interactions and information-processing activities: concurrent verbalisation (talking through problems) during operational interface issues, key interaction points, and the need for sequential operations to identify a process. Participant GP, using the washing machine, demonstrated processes that showed a requirement for sequential operations. A series of sequential operations and movements were undertaken.

Figure 4.2 shows the sequential operations used by GP. Arrows are used to show the steps used by GP. Steps are numbered from 1 to 9.

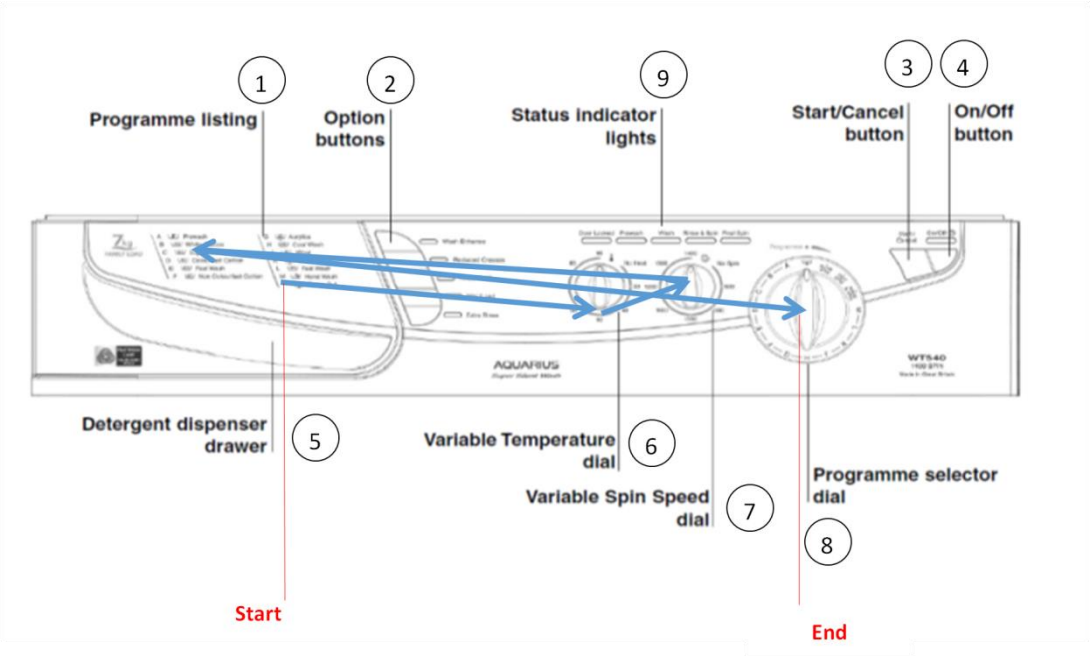


Figure 4.2(a) The Sequential Operations used by GP using the Washing Machine (Steps 1-4)

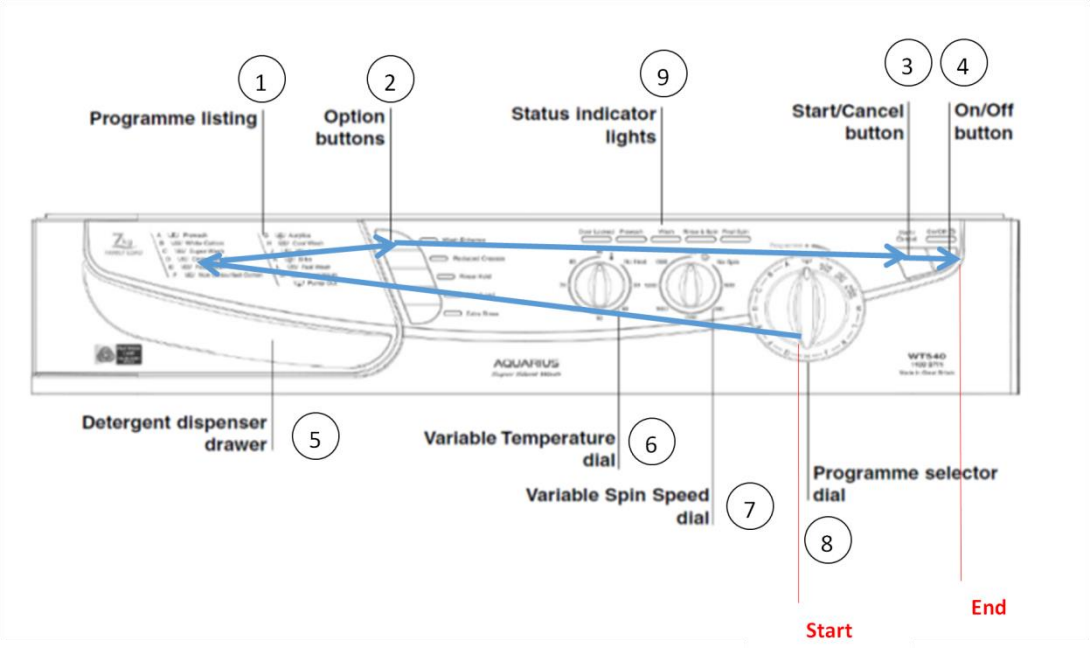


Figure 4.2(b) The Sequential Operations used by GP using the Washing Machine (Steps 5-8)

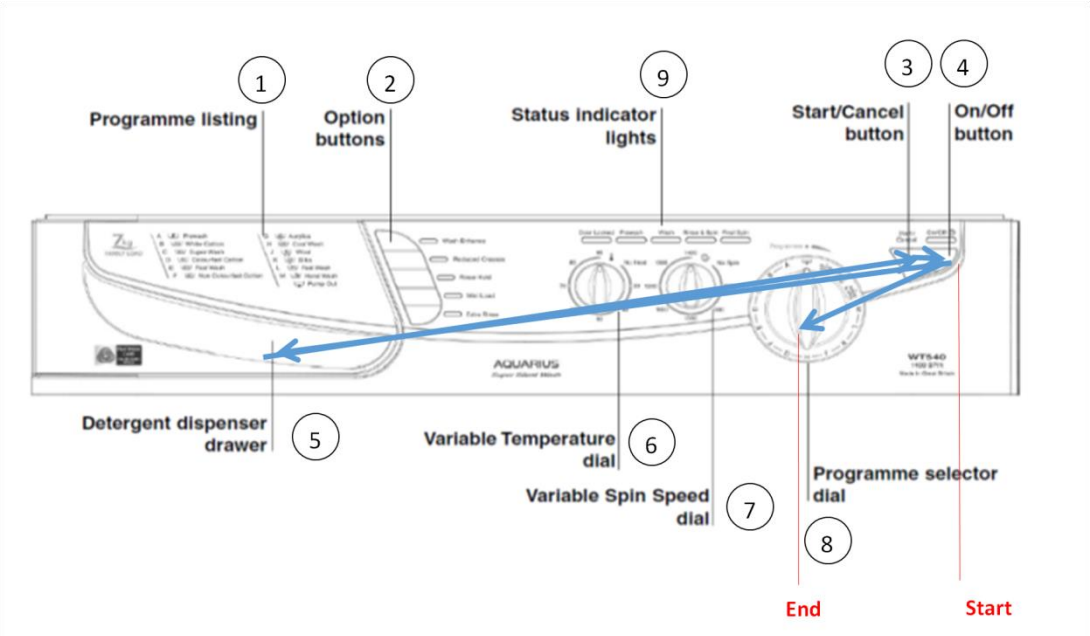


Figure 4.2(c) The Sequential Operations used by GP using the Washing Machine (Steps 9-12)

Findings suggested that participants tend to recall similarities between information on operational interfaces to self-determine operations. Information was used to make decisions on what actions were. Information was needed to learn about the operational interface and connect the actions needed to complete operations with the appliance. The information on the interfaces and its associated instructional materials failed to communicate the actions needed to operate the appliance.

Results of the analysis of the washing machine case study show 27 tactile interactions with the washing machine operational interface. Strong evidence of user interface complexity was found when this participant programmed the washing machine. It can be seen that, for this participant, the parameters, characteristics and features on the displays and controls reduced the effective transmission and reception of information between the participant and machine. Concurrent verbalisation to support problem solving provided evidence and reasons for user interface problems and issues. The data in Table 4 shows that the participant's motivations to control interaction breakdowns and focus-shifts were stimulated by information. A key finding from this experiment was that user interface elements that included visual instructions, such as symbols, icons and stylised lettering, were associated with the majority of interaction breakdowns and focus-shifts.

Results indicated that the participant was motivated by information on the user interface and components of the washing machine. For this reason, searching for meaning from user interface features was a key activity in user-product interaction. It is important to note that GP did not use the

clothing labelling or manual. What is distinct about the interaction shown in Figure 4.3 is that the arrows flow from left to right then back again. This reflects the reading of English text that is written and read from left to right. GP spent eight minutes in operations with the washing machine. Even though GP started the wash cycle, she failed to add detergent, thus, the white cotton bedding was washed but not clean.

4.2.2 Online Feedback on Microwave Oven Usability

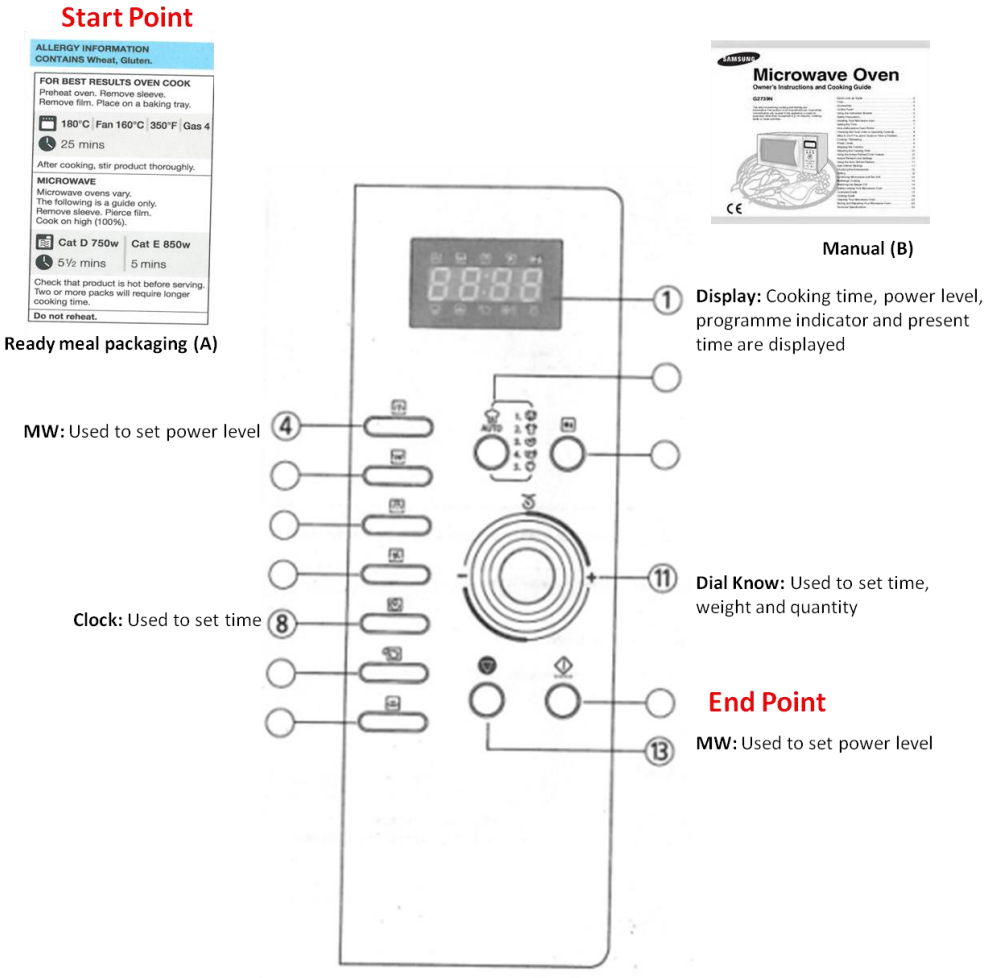
This section reports on the findings from a review of online customer feedback on the microwave oven. Findings suggested that fourteen consumers experienced difficulties with the interface and it associated instructional materials. Qualitative data suggested that information on the operational interface and instructional materials lacked adequate actionable information. Given that the microwave oven was a multifunctional and dual control appliance, consumers identified that the information was insufficient for operations with the appliance. Consumers stated that human errors were not easily identified, resolved or fixed. In addition, past experiences with other microwave oven interface could not be referred to, to better understand how to use the appliance. As a result, consumers tended not to know how to complete minor tasks or resolve errors because information given to support the step-by-step operations were inadequate and insufficient.

Consumers acknowledged past experience of the activities as an important factor in operations with the appliance. Procedural knowledge, specifically the knowledge exercised in the performance of the task. Procedural knowledge was used to enable and facilitate operations with the appliance.

Findings suggested that the operational interface and instructional manuals did not support the iterative process of learning about how to use the microwave oven. In additional, functional level language used in everyday experience of cooking was important to information-processing.

4.2.3 Observation of Participants Using the Washing Machine Appliance

Figure 4.3 shows the approach used by participant MW to operate the microwave oven. Key interaction points are shown on the microwave oven. The proportion of time spent using key interaction points on the operational interface are shown in the pie chart. In this case study dwell time was a key feature of the interactions, information-processing and impediments to workflow.



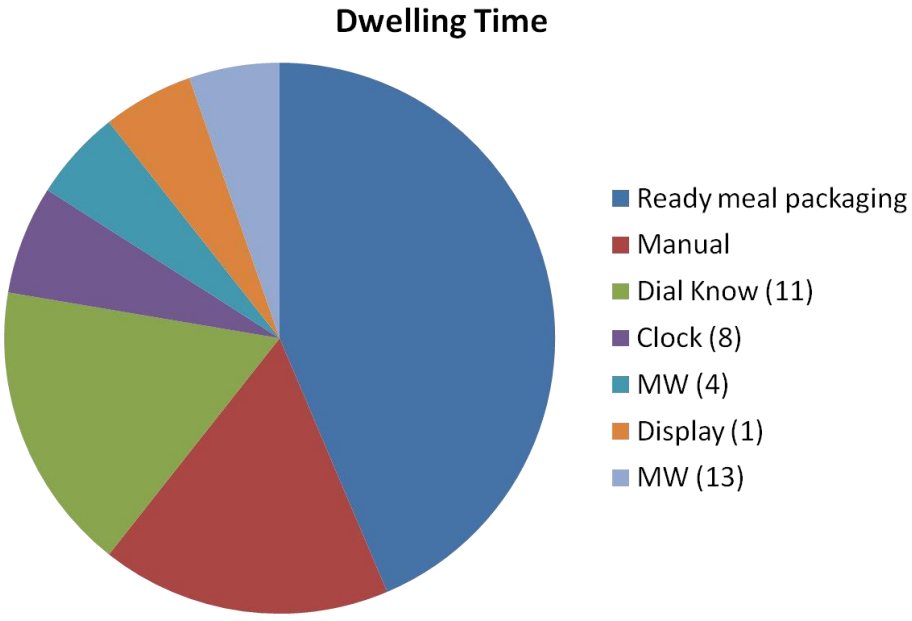


Figure 4.3 Key Interaction Points used by MW using the Microwave Oven (pie chart showing dwell time)

A key finding from this experiment was that information gathering with the meal packaging was preferred to initiate the task. The participant showed a reliance on information on the meal packaging. A large amount of time was spent identifying intentions. Developing alternative solutions followed a period of categorising information.

4.2.4 Operational Interface Issues

Participant MW used the ready meal packaging and manual. MW noticed the lack of similarities between information and instructions on the appliance and ready meal packaging. Characteristics of interactions and information-processing activities included information gathering from the ready meal packaging and manual. MW spent four minutes in operations with the microwave oven. It took MW two attempts to programme a cook cycle the microwave oven. MW started a cook cycle, but failed to heat the ready meal, thus, the ready meal was still cold. After cross referencing information on the ready meal packaging with the manual and operational interface MW started a successful cook cycle.

Comparing both participants' interactions, it became clear that each had attempted to make links between information on operational interfaces and instructional materials. However, MW demonstrated an inability to make links between information on the operational interface and its associated instructional materials. Both GP and MW referred to key interaction points on the operational interface to cross reference information in instructional materials. MW, using the microwave oven, demonstrated a limited sequential approach and focused her attention on key interaction points.

Both participants used concurrent verbalisation when experiencing difficulties in carrying out the assigned task.

Several consumers, similar to MW, found using the operational interface difficult. The qualitative data taken from fourteen online consumers responses and an analysis of footage suggested that users experienced difficulties using operational interfaces. Analysis of participants' interactions and information processing strategies collaborated case study findings. Twelve operational interface issues were identified. Table 4.2 shows the operational interface issues identified. Colours are used to differentiate between operational interface issues.

Table 4.2 The different operational interface issues identified with the microwave oven and washing machine

Operational **interface issues** **(derived from observations of microwave oven and washing machine)**
Purposeful Functional level language does not reflect the intended purpose of use or goals of the activity
Size of Visual Instructions Appropriate for Use Participants cannot see or reach the interface to operate it from a normal standing or sitting position. Acceptable display zone of between 0-45 degrees along a horizontal line of sight have not been considered
Standardised Elements Standardised Elements do not conform to either British Standards, European Legal Frameworks or Universal/User Centred Design Principles
Responsiveness to Errors Interface does not give feedback or appraisal either visual or auditory
Functional Grouping Features and elements are not arranged in function groups
Sequential Grouping Features and elements are not arranged in sequence groups
Learnability Interface does not present methods for learnability and significantly improving or maintaining operations
Flexible in Use .Interface does not provide clear visual directions or instructions for programming multiple options
Perceptibility Interface does not present information from functional level language (text, images, symbols, labels etc.,) from past experience of activities with the appliances
Intelligibility Interface does not present information that acknowledges past experience of an activity as imperative knowledge. Visual imagery and knowledge associated with the tasks and activity is not presented
Level of Cognitive Effort To understand features and elements requires higher order cognitive skills
Actionability Interface does not presents information that allows decisions to be made or actions to be taken

Tables 4.3 and 4.4 shows the qualitative data about qualities of operational interface issues; information that can't actually be measured. Tables 4.3 shows operational interface issues experienced by participants during interaction breakdowns and focus-shifts. Tables 4.4 shows operational interface issues experienced by fourteen consumers (taken from an online feedback forum).

Table 4.3 Operational Interface Issues Experienced by MW & GP(during interaction breakdowns and focus-shifts)

Washing Machine	Microwave Oven
White is very bad for my eyes	So, how do I set the time? On mine you just turn the knob and it does it. Why isn't it doing anything?
Mostly, I do things by touching not reading	I don't find this easy at all without instructions
Switch the plug on and make sure it is on	Would assume that that's your clock, but it's not doing anything
I want to wash it not boil it. It has a letter J, why?	Oh!
Is that 40 for woollen, I'm confused	Does it tell you what category it is? Is it B or E, You know, for heat
The white cotton should be 95. It should be B	On mine there's a button you press to tell you it's high. I don't know which one it is
So much writing, it should be more organized	I would assume that that's your clock. but it's not doing anything
The design is so sophisticated	Have you got anything?
Reduced crease, rinse, what does that mean?	I always assume I have got it wrong
I will leave it, I don't know how to programme it	What have I done wrong that's definitely a microwave sign?
I am not sure where the liquid goes	Yes. It says grill
I think the powder should be on the other side	Grill. Grill that's the sign on the packaging, that's why it's not done
I do not know if they are done. I still see off/on	It's the top one, number four. Shall I start again?
I still don't know what is happening?	

operational **interface issues**
Key
Lack of Purposeful
Size of Visual Instructions Appropriate for Use
Standardised Elements
Responsiveness to Errors
Functional Grouping
Sequential Grouping
Learnability
Flexible in Use
Perceptibility
Intelligibility
Level of Cognitive Effort
Actionability

Table 4.4(a) Operational Interface Issues Experienced by Consumers (online feedback forum)

Forum Questions	Consumer Online Feedback (Source Amazon.co.uk)
Question 1 Does anyone know how to change the micro. power setting on the Combination Option? I can only seem to change the oven temperature?	Just keep pressing the top button, each press reduces power by 10% by A
	Hi J, I would suggest you contact Daewoo in this regard, changing power settings should only be done through the manual instructions , if you don't have a manual, send a e mail to Daewoo, they will help , do this from a safety point of view, best regards by A
	Sorry haven't got that far ahead yet! by T
Question 2 On using for the first time I put a pie in to heat. Smoke! came from the top. Advice?	That shouldn't happen! Sent my one back-stopped working after 2 days by SL
	Definitely shouldn't have happened are you sure that you removed all the sticky tape from the inside of said m/w. There is quite a lot of it to remove, however, if you read your instructions you would know not to listen to advice because it tells you quite clearly to place a bowl of water in m/w for a number of minutes by AA
	Send it back, if smokes coming out – it's got issues by G
	Put the bowl in before the next time you use the oven and wipe out afterwards. This is to get rid of any dust and debris that may be left from the manufacturing process and is what probably caused the smoke by G
Question 3 Where can I get a manual from?	Have you tried either the Daewoo website http://www.daewooelectronics.co.uk/ or contacting Daewoo direct - Customer Services Helpline: 0844 887 2525
Question 4 What is the one touch menu?	Yes, they are for cooking joints of meat and things like pork chops and chicken pieces. You put in how many, and weight, and it cook it's perfectly via all function e.g. grill microwave and oven whichever is needed by A
	They are present, all you have to is enter the weight after selecting the food type and it will cook it pretty good - without having to keep testing.

operational interface issues Key
Purposeful
Size of Visual Instructions Appropriate for Use
Standardised Elements
Responsiveness to Errors
Functional Grouping
Sequential Grouping
Learnability
Flexible in Use
Perceptibility
Intelligibility
Low levels of Cognitive Effort
Actionability

Table 4.4(b) Operational Interface Issues Experienced by Consumers (online feedback forum)

Forum Questions	Consumer Online Feedback (Source Amazon.co.uk)
Question 5 I recently bought this item, but not sure how to use the oven. I preheated oven put in fish in tin uncovered and ended up with burnt tea! Need help!	I would suggest that you read the information on the food packaging first to ascertain which type of cooking is best for an item, after stage 1. Read your handbook on how to operate your combi oven, and then pick the correct application. Don't forget to check your oven's wattage as it can mean the difference between great cooking and a complete disaster! If you are cooking from scratch do exactly as you would for a conventional oven. Hope this helps, "Happy Cooking" mooseman222 AKA. By AA
	Sorry, I haven't used the oven yet. Good luck though refer back to the manual by T
	This is a smart looking microwave, but the icons on the front that you would press for different functions are in a very faint white colour which is very hard to see, so much so that I had to shine a light on them before I could use them. Also I had to return the microwave because the turntable started making an awful noise and stopped going round. I may have been unlucky, but I asked for a refund as I didn't want a replacement by J
	I bought this microwave as I had a previous version of this model (KOC 984T) which lasted for ten years with only a couple of minor problems. This new model does not live up to the same expectations. This model is lighter and more " flimsy and does not have as good controls. The symbols are miniscule and almost impossible to see: the grill takes so long to toast a piece of bread, mainly because the rack is way too low. The previous model had a metal plate interior, which was so much better than the glass plate of this model. I also like to use the combination option, but so far have failed to find how to alter the micro. power level - although the convection level can be changed. This means that a baked jacket potato cannot be cooked in much less time than in an ordinary oven. The instruction booklet is totally inadequate and should contain more explicit sample recipes for ALL the options not just the microwave. For some unknown reason it is also quite noisy as if something is loose in the interior. Good points are: the normal micro, convection and auto-cook options seem to work well, but as I bought it for the extra features I expected, I am really disappointed with this oven. Daewoo need to improve the design a great deal more and not sacrifice quality for "progress"?? by SP

operational interface issues **Key**
Purposeful
Size of Visual Instructions Appropriate for Use
Standardised Elements
Responsiveness to Errors
Functional Grouping
Sequential Grouping
Learnability
Flexible in Use
Perceptibility
Intelligibility
Level of Cognitive Effort
Actionability

4.2.5 Evaluative Performance Criteria

As a result of the research process evaluative performance criteria for the microwave oven and washing machine were derived. Table 4.5 shows the evaluative performance criteria. The evaluative performance criteria were used as the driver for the new operational interface design derived in Appendix A.

Table 4.5 Microwave Oven & Washing Machine Evaluative Performance Criteria & Associated Design Requirements

Evaluative Performance Criteria	Associated Design Requirements
Purposeful	The operational interface should allow participants to make meaningful connections between the information-processing task, activities, its goals and information used
Size of Visual Instructions Appropriate for Use	Ensure that participants can read the operational interface features from a minimum distance of 500mm. Ensure that participants can reach and touch the operational interface features from a normal operating position. Positioned operational interface features along the horizontal line of sight between zero and 30 degrees.
Standardised Elements	Use consistent instructions and information on operational interfaces
Responsiveness to Errors	Use visual and auditory instructions on operational interfaces
Functional Grouping	Place operational interface features in a linear operational series- constrain the series of actions if necessary
Sequential Grouping	User functional level language based on operational series based on operational interfaces.
Learnability	Use intuitive words, phrases, symbols and imagery used in early learnt experience of the activity or task
Flexible in Use	Allow participants to tailor actions, operational series and activities
Perceptibility	Use recognisable and understood words, phrases, symbols and imagery
Intelligibility	Use interpretable words, phrases, symbols and imagery
Level of Cognitive Effort	Use sequential series and auditory repetition of words, phrases, symbols and imagery to minimise cognitive overload
Actionability	Use operational series and discriminate between operational interface features

4.3 Discussion

The study incorporated activity theory methods described by Ericsson & Simon (1998), Bodker (1995) and Suchman & Trigg (1991). A benefit of using these methods lies in its focus on participants' goals and activities. By focusing on an activity and goals, the study found that operational interface issues were identified through observing natural processes. Two participants and fourteen consumers stated that the information on a washing machine, microwave oven and its associated instructional materials were insufficient or ineffective. Findings of this study relate to older adults'' operational interface issues with operational interfaces found by Young et al. (2012) and Ateca-Amestoy & Ugidos (2013). Findings suggest that operational interfaces and associated instructional materials are not aligned or connected.

This study has extended further previous studies which analyse information transfer between older adults and operational interfaces Mitchell et al. (2013) and van der Wardt et al. (2010). The findings suggested that inconsistent information on operational interface and instructional materials leads to operational interface issues. The interesting divergence between this study and Mitchell et al's (2013) study were that participants' showed a readiness to use operational sequences used in the real world task when faced with operational difficulties. Participants chose to use intuition before referring to information to action operations or process actions. Participants referred to instructional materials (the intervention) when faced with operational difficulties before improvising.

Earlier findings suggested that participants monitoring and searching for information. An example of this happened when GP was faced with operational difficulties. GP was unable to find information in specific categories such as washing because information was located in odd locations. GP searched for information to identify information categories and information continuum. MW was faced with similar operational difficulties. MW, however, showed an ability to align task information on the food packaging with operational interface. MW became aware early on that information design was inconsistent. The finding of this study suggest that the finding of Mitchell et al's (2013) is in accordance with data presented in this case study. Older learn using operational interfaces on domestic information-processing appliances by searching for, observing and checking the progress or quality of information over a period of time; keeping information under systematic review is an attribute of older adults interactions and information processing activities.

4.4 Summary

Important insights on older adults' information-processing activities and interactions using operational interfaces on domestic information-processing appliances were shown. The study found that participants experienced reduced ability to use operational interfaces on appliances because information on operational interfaces and instructional materials were not aligned or connected. Findings suggested that participants relied on information and instructions for direction and instruction. Participants searched for and gathered information, but found inconsistencies in two areas: information continuum and information categorisation. I was

concluded that designers could respond to the changing needs of older adults in two ways:

a) arrange the information on operational interfaces to reflect the sequential process of the activities of daily living:
b) make the information on operational interfaces and associated instructional materials consistent with each other.

In this chapter, evaluative performance criteria have been introduced.

Analysis of information-processing activities and interactions showed that participants responded differently when faced with operational interface issues. Differences in participants' processing, sequential operations and interaction points were found. A more detailed understanding of participants' interactions and information-processing was needed. This is reported in Chapter 5.

Chapter 5
Development of the Coding Scheme

The aim of this chapter is to report on results of a study that used theory building from case studies. The focus in this section is on methods used to develop the coding scheme for use in the assessment of participants' interactions and information-processing activities. The research instruments and participants in the experiments are summarised in Table 5.1. Section 5.1 gives an overview of the methods used in this study.

Table 5.1 Summary of instruments and participants in the experiment (reproduced from Table 4.1)

Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
GP (female) aged 55	Washing machine operational interface	Manual and clothing labels
MW (female) aged 68	Microwave oven operational interface	Manual and ready meal packaging

5.1 Method

Key aspects of the research process are shown in Figure 5.1.

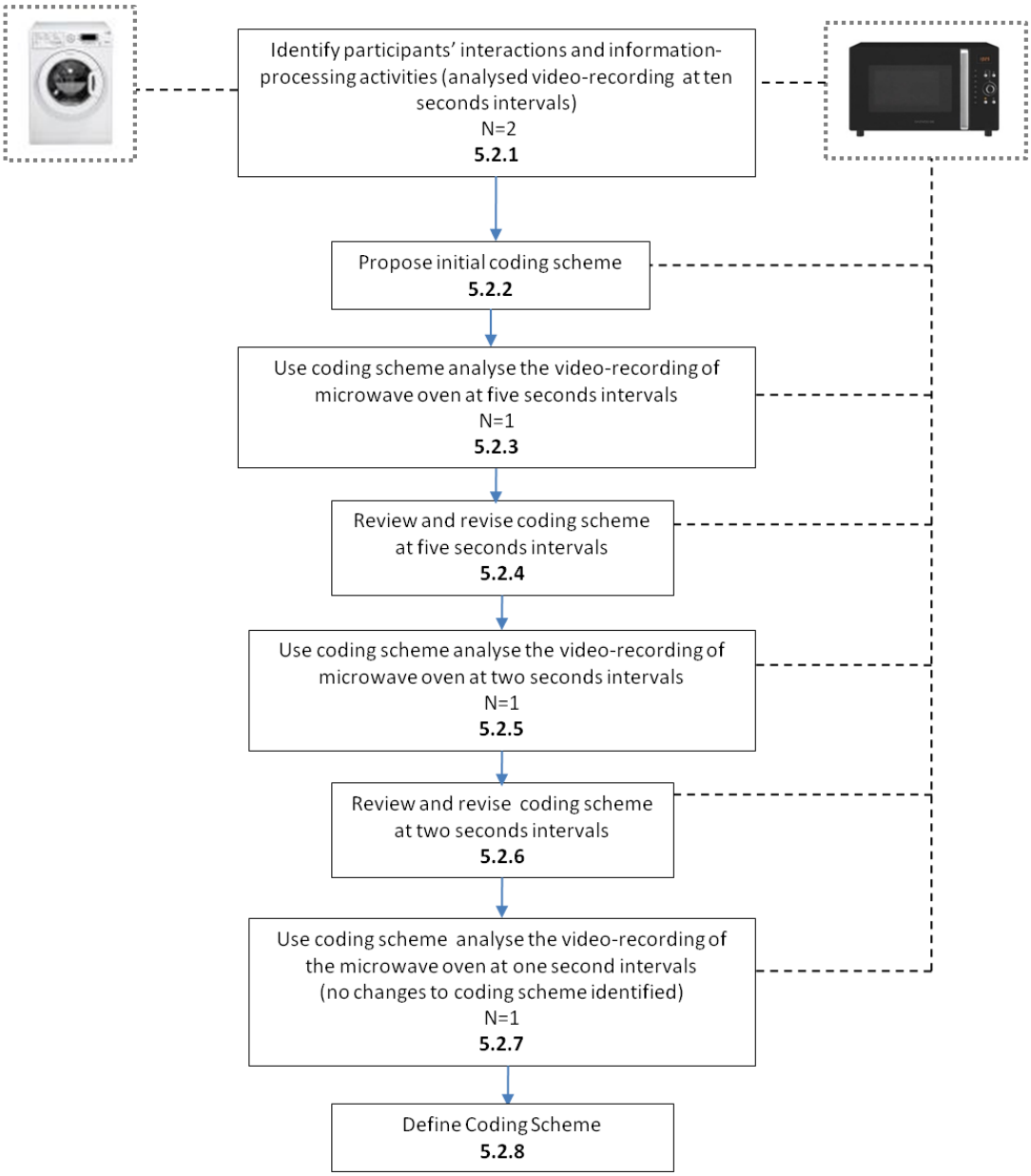


Figure 5.1 Process used to Develop Coding Scheme

The key conclusion from Stage 1 was that a detailed understanding of participants' interactions and information-processing activities were needed. The research process built on cases drawn from Eisenhardt (1988), Eisenhardt (1989) and Bourgeois & Eisenhardt (1989), and Carlile & Christensen (2004). Video-recordings of participants MW and GP's interactions and information-processing activities were analysed at ten second intervals. Thematic qualitative data analysis methods described by (Kings (2004) and Gibbs (2008) were used to identify codes and categories of interactions and information-processing activities.

Descriptions of interaction breakdowns and focus-shifts described by Winograd & Flores (1986) and Engestrome (1987) were adapted and used to identify impediments to workflow activities. Bodker (1989) and Booker (1995) three characteristics of interactions were adapted and used to identify interaction points on operational interfaces.

- Physical aspects: relating to the form and overall shapes of the physical appliance.
- Handling aspects: relating to features and elements to be operated by the hand, such as switches, plugs, buttons, and control knobs.
- Visual instructions, such as text, symbols, images, icon representation, and lettering on the appliance or instructional materials.

Information-processing skills described by Anderson & Krathwohl (2001) were adapted and used to analyse participants' information-processing activities.

Arunachalam & Sasso (1996), Atman et al. (1999) and Hughes & Parkes (2003) coding schemes were adapted and used to provide a framework for the initial coding scheme. Footage of MW's interactions and information-processing activities was analysed using the initial coding scheme at five, two and one second intervals. Data collected at two and one second intervals were put into trace format to produce protocol and verbal protocol data traces. At each step, traces were analysed using protocol and verbal protocol data analysis methods described by Patrick & James (2004). The initial coding scheme was refined and a coding scheme introduced.

5.2 Results

Results from the descriptive and experimental study are reported in this section using the structure and section numbers provided in Figure 5.1.

5.2.1 Identification of Activities, Procedures and Information-Processing

Analysis of participants' interactions and information-processing activities revealed six categories: operations; interaction points on operational interfaces; information used on operational interfaces and instructional materials; processing skills used in information-processing activities; types of impediments to workflow activities; and concurrent verbalisation. Table 5.2 and 5.3 shows participants' interactions and information-processing activities at interaction breakdowns.

Table 5.2 MW's Interactions & Information-Processing Activities using the Microwave Oven (during interaction breakdowns & focus-shifts)

Operations	Operational Interface Features	Information Types	Processing Skills Used Based on Anderson & Krathwohl (2001)	Impediment Type	Concurrent Verbalisation
Searching for Information					
Programming	Dial know	Visual Instructions	Analysing	Breakdown	So, how do I set the time? On mine you just turn the knob and it does it. Why isn't it doing anything?
Programming	Clock	Visual Instructions	Evaluating	Breakdown	I don't find this easy at all without instructions
Programming	Dial know	Visual Instructions	Analysing	Breakdown	I would assume that that's your clock but it's not doing anything
Programming	Stop/Clear	Visual Instructions	Evaluation	Breakdown	Oh!
Programming		Visual Instructions	Analysing	Focus-Shift	Does it tell you what category it is? Is it B or E, you know, for your heat!
Programming	MV	Visual Instructions	Evaluating	Focus-Shift	On mine there's a button you press to tell you it's high. I don't know which one it is
Programming	Dial know	Visual Instructions	Analysing	Focus-Shift	I would assume that that's your clock but it's not doing anything
Programming	Dial know	Visual Instructions	Analysing	Focus-Shift	Have you got anything?
Programming	Display	Visual Instructions	Evaluating	Focus-Shift	I always assume I have got it wrong

Table 5.3 GP's Interactions & Information-Processing using the Washing Machine

Operations	Operational Interface Features	Information Type	Processing Skills Anderson & Krathwohl (2001)	Impediment Type	Concurrent Verbalisation
		Handling	Remembering		White is very bad for my eyes
		Handling	Remembering		Mostly, I do things by touching not reading
		Handling	Analysing	Breakdown	Switch the plug on and make sure it is on
Programming	Programme Listing	Visual Instructions			
Programming	Programme Listing	Visual Instructions	Understanding	Focus-Shift	I want to wash it not boil it. It has a letter J, why?
Programming	Programme Listing	Visual Instructions	Applying	Breakdown	Is that 40 for woollen, I'm confused
Programming	Programme Listing	Visual Instructions	Understanding	Focus-Shift	The white cotton should be 95. It should be B
Programming	Programme Listing	Visual Instructions	Understanding	Focus-Shift	…so much writing, it should be more organized
Searching for Information	Variable Temperature Dial	Visual Instructions	Understanding	Focus-Shift	
Searching for Information	Variable Spin Speed Dial	Visual Instructions +Handling			
Searching for Information	Variable Spin Speed Dial	Visual Instructions +Handling			
Searching for Information	Programme Listing	Visual Instructions +Handling			
Searching for Information	Programme Selector Dial	Visual Instructions	Analysing		The design is so sophisticated
Searching for Information	Programme Selector Dial	Visual Instructions +Handling	Understanding	Focus-Shift	Reduced crease, rinse, what does that mean?
Searching for Information	Programme Selector Dial	Visual Instructions +Handling	Creating	Breakdown	I will leave it, I don't know how to programme it
Searching for Information	Option Buttons	Handling	Evaluating	Breakdown	I am not sure where the liquid goes
Searching for Information	Start Cancel Button	Visual Instructions	Evaluating	Breakdown	I think the powder should be on the other side
Searching for Information	On/off Button	Handling	Analysing	Focus-Shift	I do not know if they are done... I still see off/on
Application of Detergent	Detergent Dispenser Drawer	Handling		Focus-Shift	
Application of Detergent	Detergent Dispenser Drawer	Handling			
Searching for Information	Start Cancel Button	Handling			
Searching for Information	Off/On Button	Visual Instructions	Evaluating	Focus-Shift	I still don't know what is happening?
Programming	Programme Selector Dial	Handling	Understanding		
Programming	Programme Selector Dial	Handling			
Programming	Programme Selector Dial	Handling			
Programming	Programme Selector Dial	Handling			

The data shows that participants used visual instructions such as text, symbols, images, icon representation, and lettering at interaction breakdowns and focus-shifts. GP experienced a number of interaction breakdowns and focus-shifts, however, she only used visual instructions on the operational interface. On the other hand, MW experienced few interaction breakdowns and focus-shifts, however, she used visual instructions on the operational interface and its instructional materials. Both MW and GP spent a large amounts of time using information-processing skills, for example, analysing and evaluating. Noticeable findings suggested that visual instructions triggered interest from both participants.

Analysis of MW's interactions and information-processing activities at second intervals revealed details of MW's information acquisition behaviours. Tables 5.4 and 5.5 categorises MW's information-processing activities using the microwave oven in two phases. Tables 5.6 and 5.7 categorises MW's interactions using the microwave oven in two phases. Three distinctive information-processing activities were found: information gathering; obtaining information; and resolving operational interface issues using concurrent verbalisation. Four distinctive interactions were found: searching for information; problem scoping; developing alternative solutions with the operational interface; and programming.

Table 5.4 Categorising MW's Information-Processing Activities (first attempt using the microwave oven)

Information-Processing Activities	Amount of Time in the Activities (in Seconds)	Information-Processing Skills Based on Anderson (2001)
Identifying intentions (II)	00:00	Remembering
Information gathering (IG)	00:50	Analysing
Information obtained (IO)	00:30	Understanding
Identifying operational interface problems (IUIP)	00:10	Analysing
Resolving operational interface problems (RUIP)	00:00	Understanding
Identifying irrelevant operational interface information obtained (NV)	00:00	Analysing
Identifying cognition problems (ICP)	00:00	Analysing
Cognition problem resolving (CPS)	00:00	Creating
Concurrent verbalization supporting problem solving (CVSPS)	00:40	Evaluating

Table 5.5 Categorising MW's Information-Processing Activities (second attempt using the microwave oven)

Information-Processing Activities	Amount of Time in the Activities (in Seconds)	Information-Processing Skills Used Based on Anderson (2001)
Identifying intentions (II)	00:00	Remembering
Information gathering (IG)	00:40	Analysing
Information obtained (IO)	00:10	Understanding
Identifying operational interface problems (IUIP)	00:10	Analysing
Resolving operational interface problems (RUIP)	00:10	Understanding
Identifying irrelevant operational interface information obtained (NV)	00:00	Analysing
Identifying cognition problems (ICP)	00:00	Analysing
Cognition problem resolving (CPS)	00:00	Creating
Concurrent verbalization supporting problem solving (CVSPS)	01:10	Evaluating

Table 5.6 MW's Interactions (first attempt using the microwave oven)

Interactions	Amount of Time in the Activities (in Seconds)	Interactions Used based on Anderson (2001)
Searching for information (S)	01:10	Evaluating
Categorising information (CI)	00:00	Creating
Programming (P)	00:20	Applying
Problem scoping (PS)	00:20	Understanding
Checking content/equipment (UC/E)	00:10	Evaluating
Developing alternative solutions with m/c (DAS(m/c))	00:00	Creating

Table 5.7 MW's Interactions (second attempt using the microwave oven)

Interactions	Amount of Time in the Activities (in Seconds)	Interactions Used based on Anderson (2001)
Searching for information (S)	00:10	Evaluating
Categorising information (CI)	00:20	Creating
Programming (P)	00:40	Applying
Problem scoping (PS)	00:20	Understanding
Checking content/equipment (UC/E)	00:20	Evaluating
Developing alternative solutions with m/c (DAS(m/c))	00:50	Creating

Noticeable findings suggested that MW spent a large amount of time analysing and evaluating information. Whereas, in phase two, MW spent a large amount of time in information-acquisition behaviours categorises of evaluating, applying, creating and understanding.

5.2.2 Initial Coding Scheme

This section describes the initial coding scheme. MW's interactions and information processing activities were coded using the methods described in Section 5.1.

The initial coding scheme had the following categories with codes.

1. Nine information-processing activity codes.
2. Six interactions codes.
3. Two impediments to workflow activity codes.

Tables 5.5 shows the codes in the initial coding scheme.

Table 5.8 Initial Coding Scheme

Initial Coding Scheme			
Code	**Description**	**Processes Used Based on Anderson & Krathwohl (2001)**	**Data Collected Types**
Information-Processing Activities			
II	Identifying Intentions: identifying basic intentions and recalling facts	Remembering	Verbal Protocol & Protocol
IG	Information Gathering: examining and breaking information into parts	Analysing	Verbal Protocol & Protocol
IO	Information Obtained: translating and interpreting information	Understanding	Verbal Protocol & Protocol
IUIP	Identifying Operational interface Problems: inferring and finding qualitative data of visual elements problems	Analysing	Verbal Protocol & Protocol
RUIP	Resolving Operational interface Problems: translating and interpreting visual elements and information problems	Understanding	Verbal Protocol & Protocol
IIUIIO	Identifying Irrelevant Operational interface Information Obtained: examining visual elements and information to identify causes and effect	Analysing	Verbal Protocol & Protocol
ICP	Identifying Cognition Problems: breaking visual elements and information into parts by identifying causes and effect	Analysing	Verbal Protocol & Protocol
CPR	Cognition Problem Resolving: compiling information together in different ways by combining visual elements and new knowledge	Creating	Verbal Protocol & Protocol
CVSPS	Concurrent Verbalization Supporting Problem Solving: verbally verifying ideas to determine level of complexity of user interface	Evaluating	Verbal Protocol
Interactions			
SI	Searching for Information: presenting and defending opinions by making judgments about information and visual elements	Evaluating	Protocol
CI	Categorising Information: combining visual elements and information in new patterns or proposing alternative procedural solutions	Creating	Protocol
P	Programming: applying acquired knowledge, facts, techniques and rules to the user interface	Applying	Protocol
PS	Problem Scoping: demonstrating an understanding of facts and ideas relating to the procedural domain	Understanding	Protocol
CCE	Checking Content/Equipment: presenting and defending opinions by making judgments about task domain based on a set of criteria	Evaluating	Protocol
DAS	Developing Alternative Solutions with M/C: producing a plan or proposing a set of operations	Creating	Protocol
Impediments to Workflow Activity			
Code	**Description**	**Characteristics of Impediments Winograd & Flores (1986)**	**Data Collected Types**
I	Interaction Breakdown: Stop in the operational sequence (where the task was stalled)	Stop in workflow activity.	Protocol
FS	Interaction Focus Shift: Shift in the operator's attention, than a relocation to another operational interface features (where a participant is distracted from the task)	Relocation to another workflow activities	Protocol

Codes were distinctive, interpretable and required limited value judgments. Codes were used to translate into MW's interactions and information-processing activities into traces of verbal protocol and protocol data.

5.2.3 Reanalysis of Microwave Oven Video-Recordings at Five Second Intervals

Figure 5.2 shows MW's traces of interactions and information-processing activities using the microwave oven coded at five second intervals. Figure 5.2 shows differentiations between units of codes. The trace shows MW's processes, for example, the operational sequences used.. The traces shows MW's responses to different types of operational interface issues and reflect the differences in understanding of the task. Hence, results confirm that the trace method was an appropriate method by which to assess MW's interactions and information-processing activities.

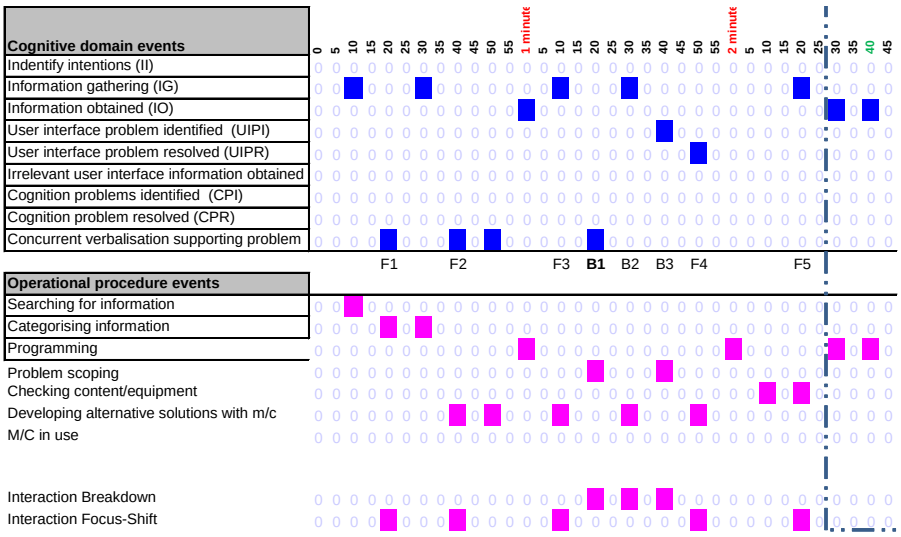


Figure 5.2 MW's Traces using the Microwave Oven (coded at five second intervals)

5.2.4 Review of Initial Coding Scheme at Five Second Intervals

Data retrieval at five second intervals indicated that the initial coding scheme could be used to capture contextual data. However, the reasons for interaction breakdowns and focus-shifts were vague. In addition, the traces were sparsely populated with codes. .

At five second intervals the coding scheme showed.

- Information-processing activities and interactions, but limited reason for impediments to workflow activities.
- Some categories of recorded coded units.
- Single classification of codes.
- Independent categories and codes.
- Differences among categories which were meaningful.

The footage was analysed at two second intervals.

5.2.5 Reanalysis of Microwave Oven Video-Recordings at Two Second Intervals

Figure 5.3 shows MW's traces of interactions and information-processing activities using the microwave oven coded at two second intervals. Figure 5.3 shows greater differentiations between units of codes. The trace shows MW's processes, for example, the operational sequences used. In addition, the ways in which MW transcends and overlapping between units of codes. The trace reflect more of MW's interactions and information-processing activities with the operational interface and its instructional materials. The traces shows MW's responses to different types of operational interface

issues, reflecting the differences in understanding of the task, and potential reason for interactions breakdown and focus shifts

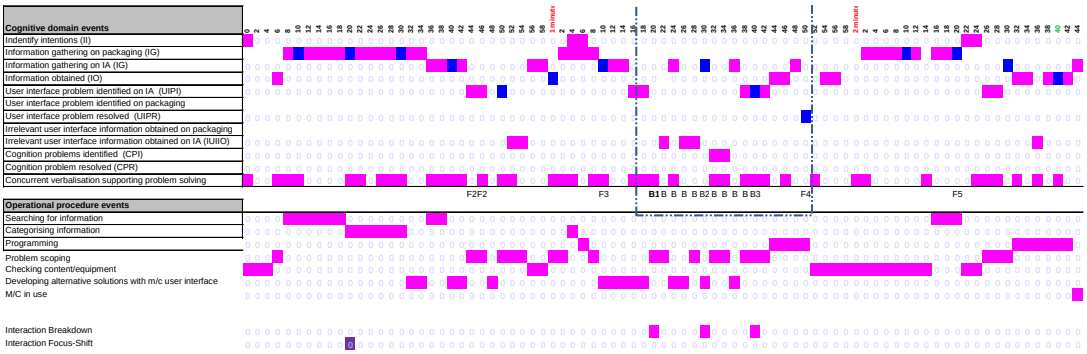


Figure 5.3 MW's Traces Using the Microwave Oven (coded at two second intervals) (See Appendix E)

Figure 5.4 shows the same trace annotated to describe interactions and information-processing activities.

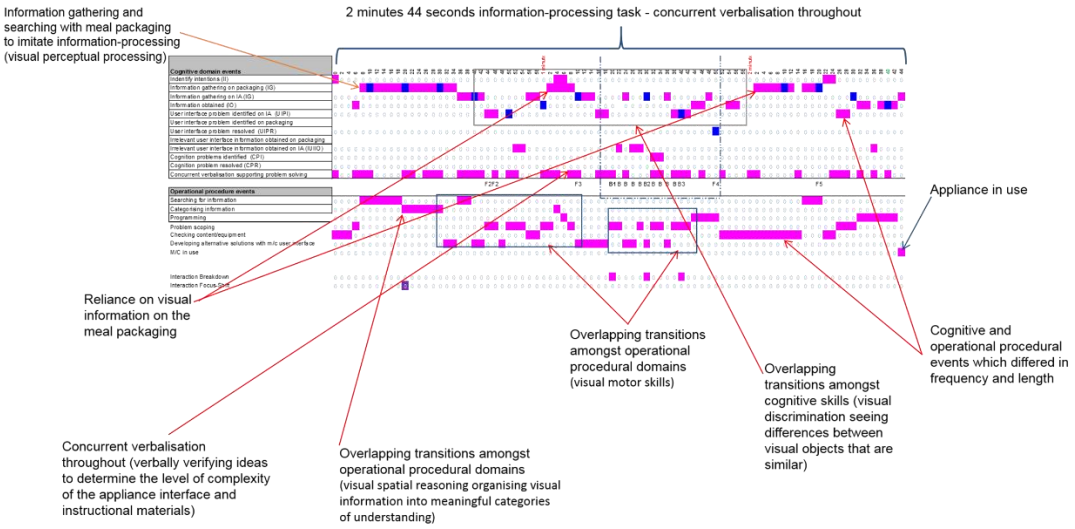


Figure 5.4 MW's Traces Using the Microwave Oven (coded at two second intervals with annotations) (See Appendix E)

Noticeable findings included the following.

- Information gathering with the meal packaging to initiate the information-processing task.
- The user showed a reliance on the information on the meal packaging
- Information on the interface was not reviewed before the start of the activity.
- Operational interface issues were noticed in advance of a series of interaction breakdowns and focus-shifts.
- Overlapping transitions amongst information-processing skills events and operational procedural domains were a key feature of the interaction and associated information-processing.
- Cognitive and operational procedural events differed in frequency and length.
- Developing alternative solutions followed a period of categorising information.
- Interaction breakdowns coincided with programming the interface and searching for information on associated instructional materials.

5.2.6 Review of Initial Coding Scheme at Two Second Intervals

Data retrieval at two second intervals indicated that the initial coding scheme could be used to capture more contextual data. Additional information-processing activity codes were identified and added to information-processing activity codes. Table 5.9 shows the nine information-processing activity codes identified. Noticeable finding were that eight of the codes were

in the information-processing activity area of analysing, for example, Information gathering from the appliance manual.

Table 5.9 Additional Information-Processing Activities Identified at Two Second Intervals

Information-Processing Requirements	Information-Processing Skills Definition	Processing Skills based on Anderson & Krathwohl (2001)
Information gathering from the meal packaging	Breaking-up and examining information in parts for visual instructions on the ready meal packaging*	Analysing
Information gathering from the appliance manual	Breaking-up and examining information in parts for visual instructions on the appliance operational interface manual*	Analysing
Information gathering from the appliance user interface	Breaking-up and examining information in parts for visual instructions on the appliance user interface*	Analysing
Operational interface problems identified on the information appliance user interface	Finding visual elements problems with the appliance user interface*	Analysing
Operational interface problems identified on meal packaging	Finding visual elements problems with the meal packaging*	Analysing
Irrelevant information from meal packaging	Examining visual information on meal packaging to identify cause and effect*	Analysing
Irrelevant information from appliance operational interface	Examining visual information on appliance operational interface to identify cause and effect*	Analysing
Visual cognition problem identified	Breaking-up visual information in parts identifying visual cause and effect*	Analysing
Visual cognition problem resolved	Compiling information together in different ways to combine new knowledge and visual elements*	Creating

At two second intervals the coding scheme showed.

- Nine additional information-processing activities codes
- Differences between information-processing activities with the operational interface and instructional materials.
- Clear units and categories for coding information-processing activities and interactions.
- Influences and effects of interaction breakdowns and focus-shifts.

The video-recording was reanalysed at one second intervals.

5.2.7 Reanalysis of Microwave Oven Video-Recordings at One Second Intervals

Data retrieval at one second intervals indicated that the initial coding scheme could not be used to capture any more contextual data. Hence, no new codes could be identified. All concepts in the coding scheme were considered developed. Data retrieved at two seconds intervals were shown to be the most reliable method. The coding scheme threshold for data collection and analysis was set at two second intervals.

5.2.8 Coding Scheme

This section describes the coding scheme. Tables 5.10 shows the coding scheme.

Table 5.10 Coding Scheme

Coding Scheme			
Code	**Description**	**Based on Anderson & Krathwohl (2001)**	**Data Collected Types**
Information-Processing Activities			
II	Identifying Intentions: identifying basic intentions and recalling facts	Remembering	Verbal Protocol & Protocol
IG	Information Gathering: examining and breaking information into parts	Analysing	Verbal Protocol & Protocol
IO	Information Obtained: translating and interpreting information	Understanding	Verbal Protocol & Protocol
IUIP	Identifying Operational interface Problems: inferring and finding qualitative data of visual elements problems	Analysing	Verbal Protocol & Protocol
RUIP	Resolving Operational interface Problems: translating and interpreting visual elements and information problems	Understanding	Verbal Protocol & Protocol
IIUIIO	Identifying Irrelevant Operational interface Information Obtained: examining visual elements and information to identify causes and effect	Analysing	Verbal Protocol & Protocol
ICP	Identifying Cognition Problems: breaking visual elements and information into parts by identifying causes and effect	Analysing	Verbal Protocol & Protocol
CPR	Cognition Problem Resolving: compiling information together in different ways by combining visual elements and new knowledge	Creating	Verbal Protocol & Protocol
CVSPS	Concurrent Verbalization Supporting Problem Solving: verbally verifying ideas to determine level of complexity of user interface	Evaluating	Verbal Protocol
IGMP	Information gathering from the meal packaging	Analysing	Verbal Protocol & Protocol
IGAM	Information gathering from the appliance manual	Analysing	Verbal Protocol & Protocol
IGAUI	Information gathering from the appliance user interface	Analysing	Verbal Protocol & Protocol
OIPAUI	Operational interface problems identified on the information appliance user interface	Analysing	Verbal Protocol
OIPMP	Operational interface problems identified on meal packaging	Analysing	Verbal Protocol
IIMP	Irrelevant information from meal packaging	Analysing	Verbal Protocol
IIAOP	Irrelevant information from appliance operational interface	Analysing	Verbal Protocol
VCPI	Visual cognition problem identified	Analysing	Verbal Protocol & Protocol
VCPR	Visual cognition problem resolved	Creating	Verbal Protocol & Protocol
Interactions			
SI	Searching for Information: presenting and defending opinions by making judgments about information and visual elements	Evaluating	Protocol
CI	Categorising Information: combining visual elements and information in new patterns or proposing alternative procedural solutions	Creating	Protocol
P	Programming: applying acquired knowledge, facts, techniques and rules to the user interface	Applying	Protocol
PS	Problem Scoping: demonstrating an understanding of facts and ideas relating to the procedural domain	Understanding	Protocol
CCE	Checking Content/Equipment: presenting and defending opinions by making judgments about task domain based on a set of criteria	Evaluating	Protocol
DAS	Developing Alternative Solutions with M/C: producing a plan or proposing a set of operations	Creating	Protocol
Impediments to Workflow Activity			
Code	**Description**	**Characteristics of Impediments Winograd & Flores (1986)**	**Data Collected Types**
I	Interaction Breakdown: Stop in the operational sequence (where the task was stalled)	Stop in workflow activity.	Protocol
FS	Interaction Focus Shift: Shift in the operator's attention, the relocation to another operational interface features (where a participant is distracted from the task)	Relocation to another workflow activities	Protocol

The initial coding scheme had the following categories with codes.

1. Eighteen information-processing activity codes.
2. Six interactions codes.
3. Two impediments to workflow activity codes.

The coding scheme showed that it could be used in the assessment of participants' interactions and information-processing activities. The advantages of using a coding scheme were that it could be used to code natural processes and interactions.

The coding scheme was considered to be a clear and simple data collection and analysis tool to collect and analyse data for use in the assessment of participants' interactions and information-processing activities. In addition, data can be analysed quantitatively and qualitatively.

5.3 Discussions

By focusing on participants' sequential operations, interactions, procedures and activities using methods described by (Kings (2004) and Gibbs (2008) respectively), the study found that participants' interactions and information processing activities could be identified and coded. Results suggested that participants used process-specific lateral interactions in the task. Results suggested participant MW aligned information on the operational interface with instructional materials. Visual instructions on the operational interface were unfamiliar to MW. Results suggested these unfamiliar and uninterruptable visual information caused the majority of interaction breakdowns and focus-shifts. In addition, these visual instructions remained active in MW's working memory. For example, MW used concurrent verbalisation during interaction breakdowns and focus-shifts. Similar to the

finding of Old & Naveh-Benjamin (2008) the results suggested that MW showed an inability to align inconsistent information. In addition, on occasions, MW found it difficult to determine the meaning of visual instructions. MW used visual instructions when faced with a limited sequential operations.

The coding scheme provided a method to detail the relationships between Mw's information acquisition behaviours and information-processing. The circular relationships between information information-processing is suggested by Rose et al. (2010). However, this study showed that MW made value and connection (the importance, worth, or usefulness) between information on operational interfaces and instructional materials. MW showed a readiness to read instructions on the ready meal packaging to align her foundation knowledge with the information. Task and functional level language was used to influence actions. Unlike Rose et al's (2010) study, this study found that the coding scheme could be used to identify participants' conscious and unconscious interactions and information-processing activities

5.4 Summary

In this chapter, a coding scheme was introduced. The coding scheme was used to provide a detailed assessment of participants' interactions with operational interfaces and instructional materials. Video footage of the microwave oven was used to produce the coding scheme. Three coding categories were derived: eighteen information-processing activity codes, nine interactions codes and two impediments to workflow activity codes. Evaluations of MW's information-processing activities and interactions

indicated that MW talked through operational interface issues. The study identified the importance of participants' foundation knowledge (at task and functional level language) which was used to influence actions. The study found that visual instructions were used by participants' to determine interactions and information-processing activities. Results indicated that visual instructions on operational interface and instructional materials caused the majority of interaction breakdowns and focus-shifts.

The coding scheme was used to assess and compare participants' interactions and information-processing activities compared to participants using the two interfaces. This is reported in Chapter 6. Before the coding scheme could be used, an alternative operational interface design for use in the assessment of participants' interactions and information-processing activities was derived (see Appendix A). The next chapter 6 reports on results of the study that compared participants using the two interfaces to assess participants' interactions and information-processing activities

Chapter 6
A Comparison of a New Microwave Oven Operational Interface Design with the Current Design

The aim of this chapter is to report on results of a study that compared participants using the two interfaces to assess participants' interactions and information-processing activities. The study compared a new operational interface design for the microwave oven with the current one.

6.1 Development Process For the New Operational Interface

The research instruments and participants used in the design and development for the new operational interfaces is summarised in Table 6.1.

Table 6.1 Summary of Instruments and Participants in the Development of the Operational Unser Interface

Combinations of participant, appliance and interface used	**Research Instruments**	
Participants	**User interface**	**Instructional Materials**
VA (female) aged 61	Microwave oven operational interface	Manual and ready meal packaging
FG (female) aged 68		
TC (male) aged 58		

The focus in this section is on the methods used to develop the new operational interface. An experimental research process of design-led action research was used. The research process built on cases drawn from van de Ven's (2006, 2007). The process included the use of action research methods described by Fendt & Kaminska-Labbe (2011) to develop a series of prototypes for the new operational interface for the microwave oven. The key conclusion from Chapter 5 was that visual instructions and information on the operational interface caused distractions and interruptions to workflow activities. A more detailed understanding of how visual instructions and information could be used was used to inform the improvement to the interactions and information-processing activities with the interface. Key steps in the development process are shown in Figure 6.1, which ended in the definition of a new operational interface design.

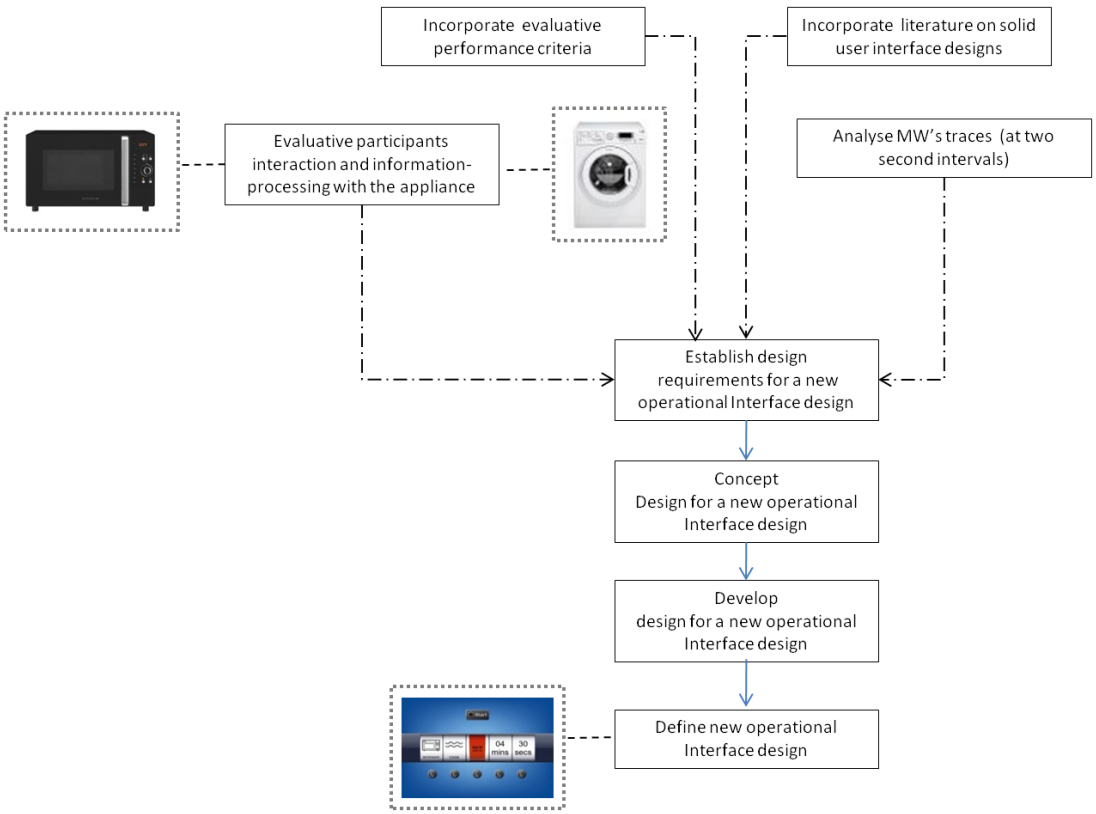


Figure 6.1 Amount of Time Participants Spent in Impediments to Workflow

Design concepts were generated using augmented and alternative communication techniques described by Grove's (1990). They were used to facilitate an improved understanding of the use of written visual and none visual instructions. This provided a standardised visual communication language for the development of the new operational interface. Design requirements were specified based on participants needs and operational interface issues encountered. Appendix A outlines the design and development process used to create the new operational interface. Design-led action research methods were used to generate design requirements, design concepts and prototypes Design features and characteristics identified through explorations with prototypes were as follows.

- Displaying words, phrases, symbols and imagery in sequential series.
- Displaying the whole information-processing task in full on the operational interface.
- Constraining dynamic actions and operations.
- Displaying words, phrases, symbols and imagery based on functional level language used in the real world.
- Using visual and auditory instructions.
- Allowing participants to access visual and auditory instructions on demand.
- Discriminating between operational interface features.
- Using categories of information.
- Using information continuum.
- Using touch modalities such as gesture.
- Using a linear operational series.
- Using animated and dynamic operational interface features and characteristics.

These design requirements were considered necessary and feasible to achieve interface usability. Design concepts and prototypes were analysed using process-specific lateral interaction methods described by Freeman et al. (2001, 2002, 2005 & 2014). Prototypes were refined in a series of steps using three users. The final design definition was put into app format onto an IPad. The final operational interface design definition was prototyped using an app format on an iPad. Figure 6.1 shows the new operational interface and its key features and characteristics.

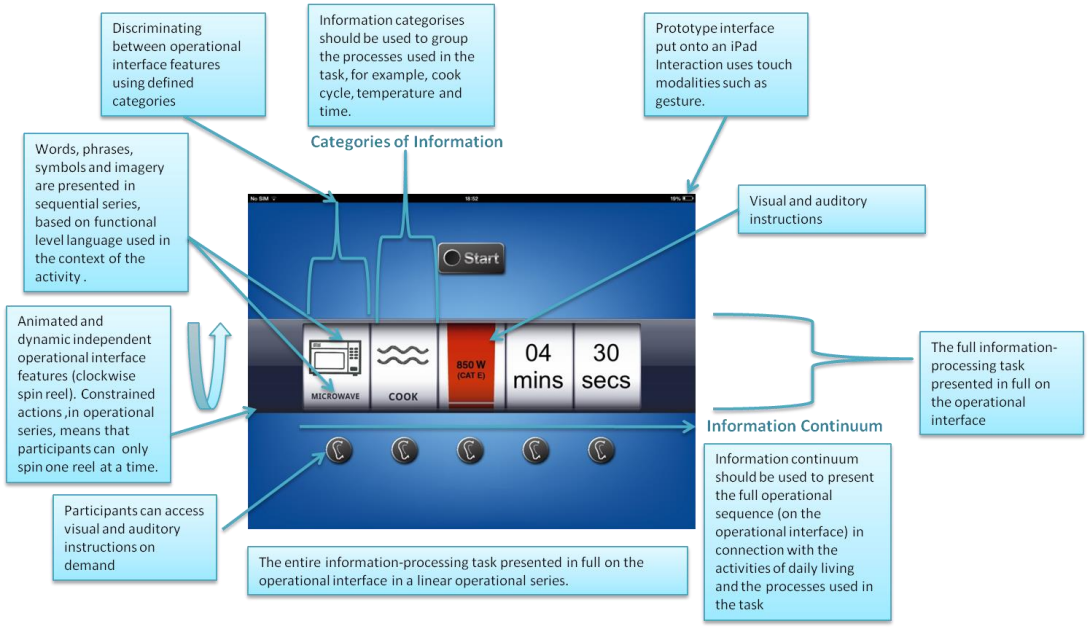


Figure 6.2 New Operational Interface on iPad (reproduced from Figure 3.5)

6.2 Method

Key aspects of the research process are shown in Figure 6.3.

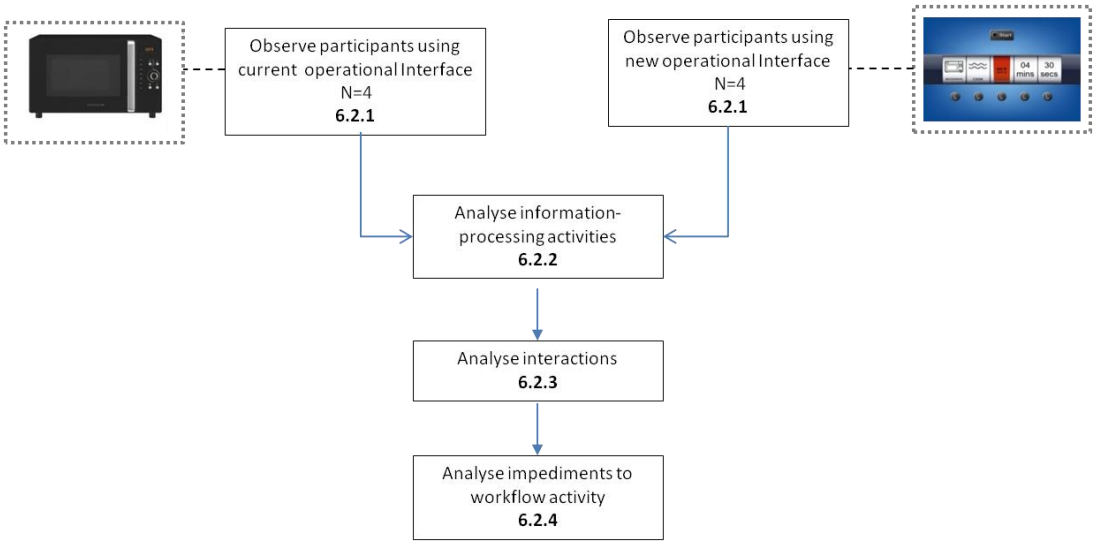


Figure 6.3 Process Used to Compare the New Operational Interface with the Current

The research process built on methods used in Chapter 4 and case studies drawn from Lincoln & Guba (1985). Two empirical studies with eight participants, four using a new microwave oven interface and the others using a current microwave oven interface were carried out. Data was collected and analysed using the coding scheme. Case study methods suggested by Carlile & Christensen (2004), Yin (1994) and Yin (2009) were used to compare data for empirical studies. Comparisons were made between individuals in sub-groups, across age ranges and between interfaces. Data was analysed using the following criteria:

- Information-processing requirements;
- Operational procedures;
- Impediments to workflow activity;
- Operational procedural domains;
- Information-processing skills requirements;
- Overlapping transitions among operational procedural domains; and
- Overlapping transitions among information-processing skills requirements.

Table 6.2 gives an overview of the methods used in the study. Findings from the analysis are discussed in the next Section 6.3.

Table 6.2 Summary of Instruments & Participants in the Experiment Adapted from Chapter 4 (all female)

Combinations of participant, appliance and interface used	Research Instruments	
Participants	**User interface**	**Instructional Materials**
(DH) Aged 67	Current microwave oven operational interface	Meal Packaging & Manual
(AD) Aged 68	Current microwave oven operational interface	Meal Packaging & Manual
(JB) Aged 72	Current microwave oven operational interface	Meal Packaging & Manual
(ST) Aged 74	Current microwave oven operational interface	Meal Packaging & Manual
(SL) Aged 65	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(CMK) Aged 69	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 70	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging
(JH) Aged 74	New microwave oven operational interface on an IPad	Written instructions & Meal Packaging

6.3 Results

Results from the descriptive study are reported in this section using the structure and section numbers provided in Figure 6.3.

6.3.1 Observations of Participants using Current & New Operational Interfaces

Data was retrieved using the coding framework at two second intervals. Figures 6.4 to 6.11 shows participants' traces (See Appendix E for A3 copies of traces). Five key characteristics of participants' information-processing activities and interactions were observed:

a) an inability to differentiate between irrelevant and relevant information;

b) attention decline;

c) concentration decline;

d) ineffective information retrieval methods; and

e) effective information retrieval methods.

Figure 6.4 shows participant DH's information-processing activities and interactions.

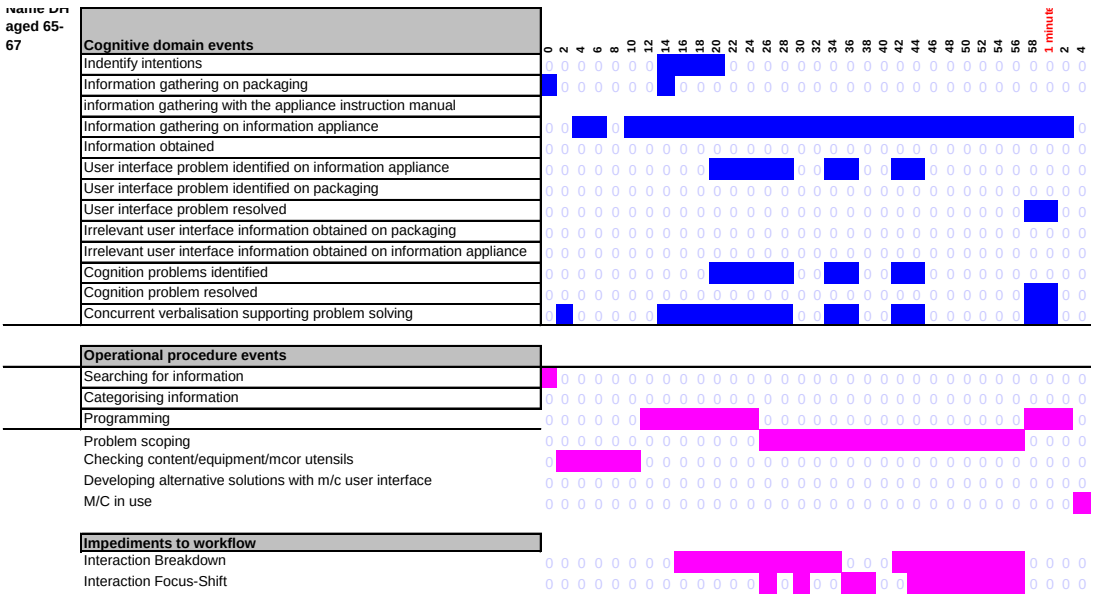


Figure 6.4 DH's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- DH spent a limited amount of time reviewing the instructions on the packaging, preferring information gathering with the interface to initiate the process.

- Information gathering with the interface formed the greatest proportion of information-processing activities.
- DH did not make an attempt to review the instruction on the ready meal packaging before starting the task.
- DH relied on information gathering with the interface.
- Problem scoping formed the greatest proportion in interactions.
- DH becomes aware quickly of the inconsistent information on the appliance. DH identified operational interface problems approximately 20 seconds into a 60 second task.
- Operational interface issues were not noticed in advance of a series of interaction breakdown and focus-shifts.
- Interaction breakdowns were followed by frequent focus-shifts that became more intermittent and frequent toward the end of the task.

After a programming time of one minute and four seconds, the task ended with the interface successfully programmed to heat the ready meal.

Figure 6.5 shows participant AD's information-processing activities and interactions.

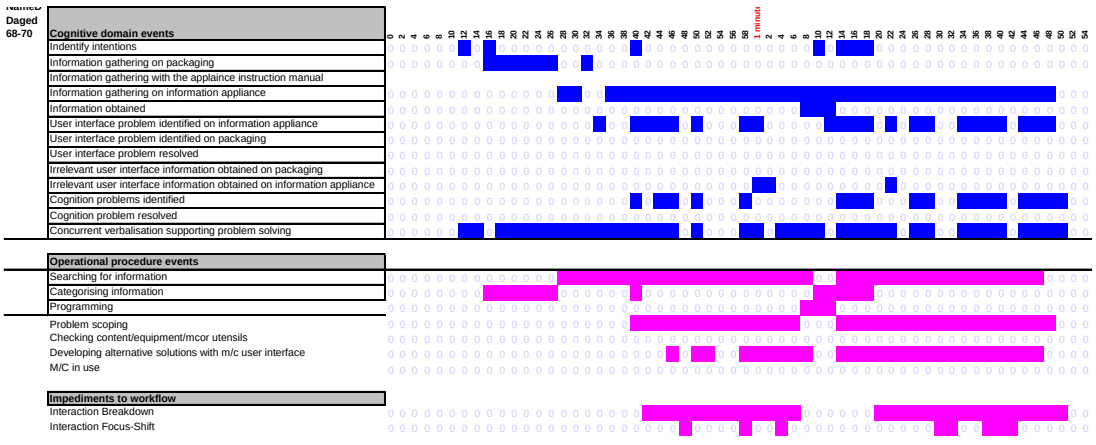


Figure 6.5 AD's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- AD preferred information gathering with the packaging to initiate the task.
- Concurrent verbalisation coincided with information gathering on the interface.
- Information gathering with the interface formed the greatest proportion of information-processing activities.
- Searching for information, categorising information, problem scoping and developing alternative solution with the appliance interface formed the greatest proportion of interactions.
- AD become aware quickly of the inconsistent information on the interface.
- Operational interface issues were noticed in advance of interaction breakdown and short focus-shifts.
- AD did not reviewed the instruction on the packaging before starting the task.
- AD relied on information gathering with the interface.

After a programming time of one minute and fifty seconds, the task ended with the interface unsuccessfully programmed. Figure 6.6 shows participant JB's information-processing activities and interactions.

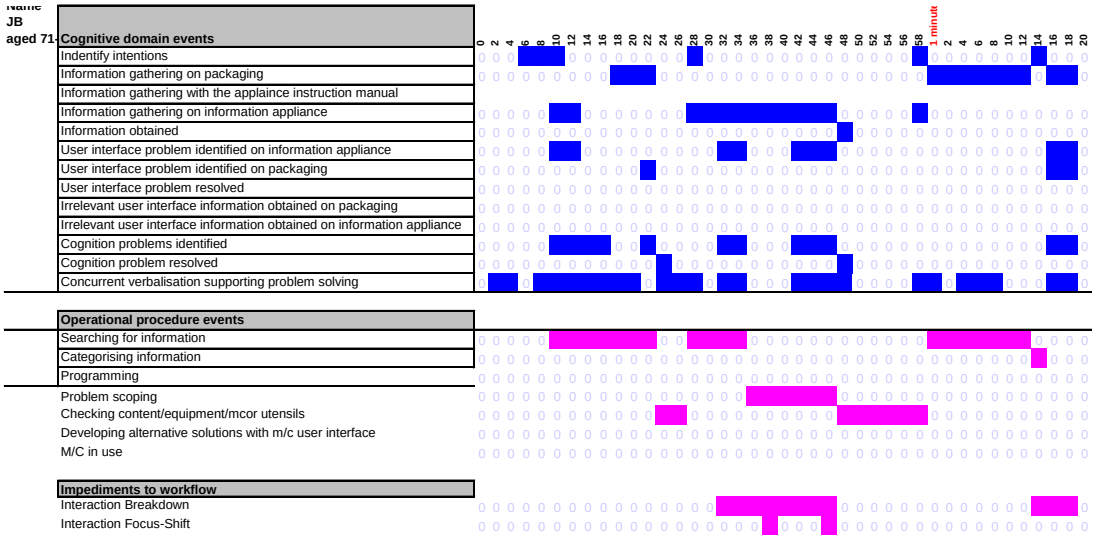


Figure 6.6 JB's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- JB preferred to identify her intentions as a mean of initiating the task.
- JB preferred information gathering with the interface.
- Operational interface issues with the interface cognition were identified early in the task, before a series of interaction breakdowns occurred.
- Concurrent verbalisation supporting problem solving formed the greatest proportion of information-processing activities.
- Searching for and gathering information formed the greatest proportion of interactions.
- JB became aware of the inconsistent information on the interface, before reviewing the instruction on the ready meal packaging.
- JB relied on the instruction on the packaging and the interface.

After a programming time of one minute and eighteen seconds, the task ended with the interface unsuccessfully programmed. Figure 6.7 shows participant ST's information-processing activities and interactions.

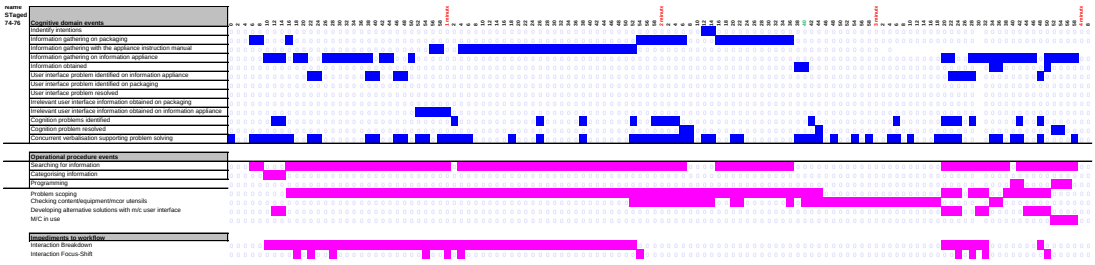


Figure 6.7 ST's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- ST preferred information gathering with the instructions on the ready meal to initiate the task.
- Information gathering with the interface and instruction manual formed the greatest proportion of information-processing activities.
- Problem scoping and searching for information formed the greatest proportion of interactions.
- ST becomes aware of the inconsistent information on the interface and manual.
- Operational interface issues noticed early in the task.
- ST review relied on interface to resolve operational interface issues.

Figure 6.8 shows participant SL's information-processing activities and interactions. After a programming time of one minute and two seconds, the task ended with the interface unsuccessfully programmed.

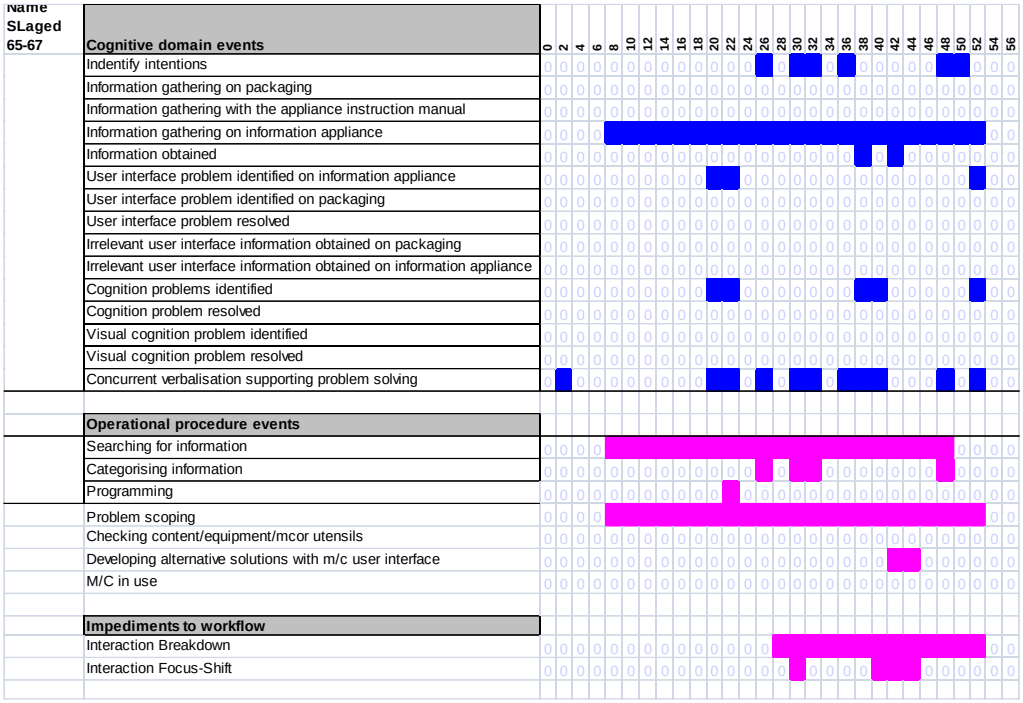


Figure 6.8 SL's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- SL spent a limited amount of time on information gathering with the interface.
- Information gathering with the interface formed the greatest proportion of information-processing activities.
- Searching for information and problem solving formed the greatest proportion of interactions.
- SL did not make an attempt to review the instruction on the ready meal packaging before starting the task.
- SL relied on information gathering with the interface.
- SL becomes aware of inconsistent information on the appliance.

- Operational interface issues were noticed in advance of a series of interaction breakdown and focus-shifts.
- Interaction breakdowns were followed by frequent focus-shifts that became more intermittent and frequent toward the end of the task.

After a programming time of one minute and eighteen seconds, the task ended with the interface successfully programmed in heating the ready meal. Figure 6.9 shows participant CMK's information-processing activities and interactions

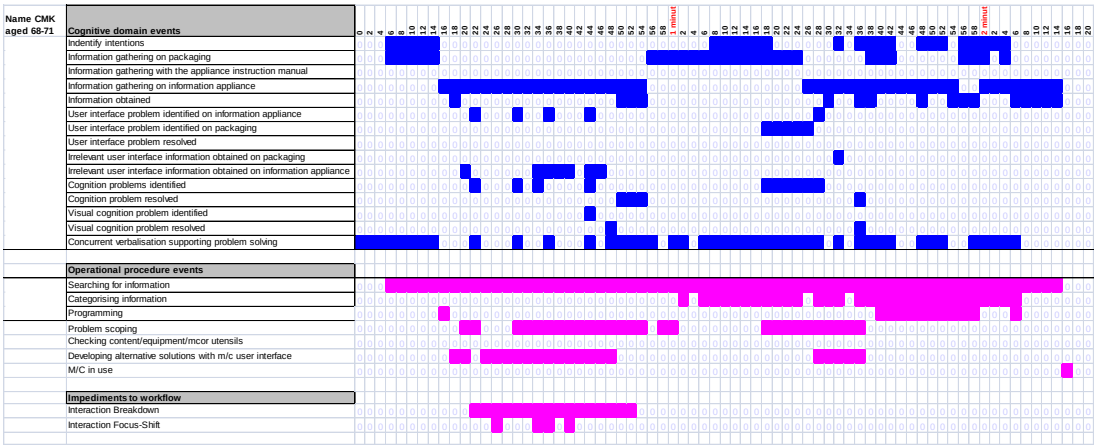


Figure 6.9 CMK's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- CMK preferred information gathering with the packaging to initiate the task.
- Concurrent verbalisation coincided with information gathering on the interface.
- Information gathering with the interface formed the greatest proportion of information-processing activities.
- Searching for information, categorising information, problem scoping and developing alternative solution with the operational interface formed the greatest proportion of interactions.
- CMK become aware of inconsistent information on the interface.
- Operational interface issues were not noticed in advance interaction breakdown and short focus-shifts.
- CMK did review the instruction on the packaging before starting the task.

After a programming time of two minute and sixteen seconds, the task ended with the interface successfully programmed to heat the ready meal.

Figure 6.10 shows participant JH’s information-processing activities and interactions.

Name JHaged 70-73	Cognitive domain events	0	2	4	6	8	10
	Indentify intentions	0	0	0	0	0	0
	Information gathering on packaging	0	0	0	0	0	0
	Information gathering with the appliance instruction manual	0	0	0	0	0	0
	Information gathering on information appliance						0
	Information obtained	0	0	0	0	0	0
	User interface problem identified on information appliance	0	0	0			0
	User interface problem identified on packaging	0	0	0	0	0	0
	User interface problem resolved	0	0	0	0	0	0
	Irrelevant user interface information obtained on packaging	0	0	0	0	0	0
	Irrelevant user interface information obtained on information appliance	0	0	0	0	0	0
	Cognition problems identified	0	0	0			0
	Cognition problem resolved	0	0	0	0	0	0
	Visual cognition problem identified	0	0	0	0	0	0
	Visual cognition problem resolved	0	0	0	0	0	0
	Concurrent verbalisation supporting problem solving	0	0				0
	Operational procedure events						
	Searching for information					0	0
	Categorising information	0	0	0	0	0	0
	Programming	0	0	0	0	0	0
	Problem scoping					0	0
	Checking content/equipment/mcor utensils	0	0	0	0	0	0
	Developing alternative solutions with m/c user interface	0	0	0	0	0	0
	M/C in use	0	0	0	0	0	0
	Impediments to workflow						
	Interaction Breakdown						0
	Interaction Focus-Shift	0	0	0	0	0	0

Figure 6.10 JH's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- JH spent a limited amount of time information gathering with the interface.
- Searching for information and problem scoping formed the greatest proportion of interactions.
- JH did not make an attempt to review the instruction on the ready meal packaging before starting the task.

- JH relied on information gathering with the interface.
- JH becomes aware of inconsistent information on the appliance.
- Operational interface issues were noticed at the same time of an interaction breakdown.

After a programming time of eight seconds, the task ended with the interface unsuccessfully programmed. Figure 6.11 shows participant JH information-processing activities and interactions.

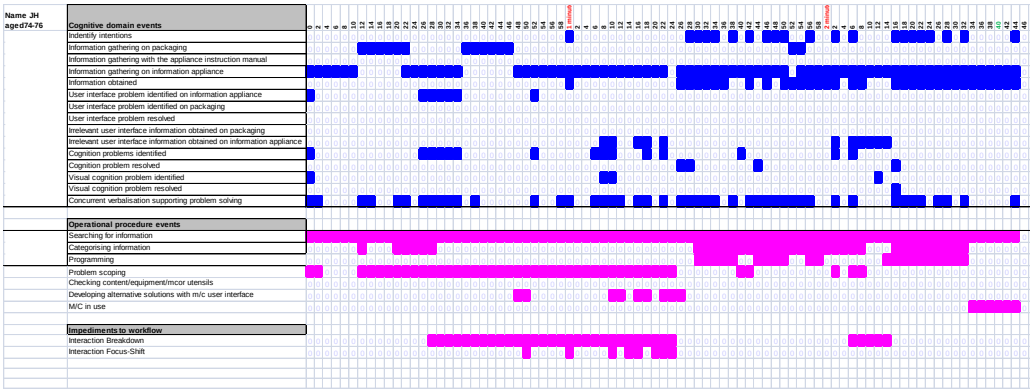


Figure 6.11 JH's Traces using the Current Operational Interface (coded at two second intervals)

Noticeable findings are as follows.

- JH preferred information gathering with the interface.
- Problem scoping, searching for information and categorising information formed the greatest proportion of interactions.
- JH becomes aware of the inconsistent information on the interface.
- Operational interface issues noticed early in the task.

After a programming time of two minutes and forty four seconds, the task ended with the interface unsuccessfully programmed. Figures 6.12

compared participants' interactions and information-processing activities, use of interfaces and instructional materials in relation to participants successful and non-successful completion of the task.

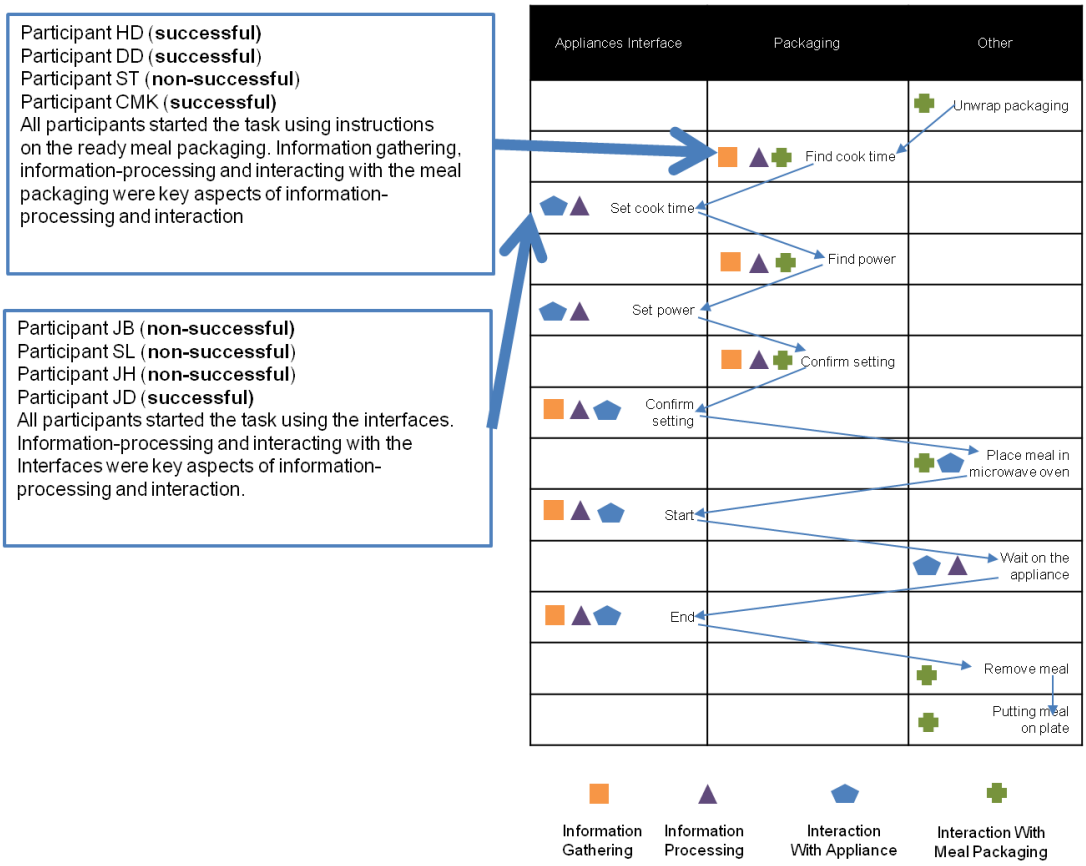


Figure 6.12 Comparisons of Participants' Interactions & Information-Processing Activities using Interfaces & Instructional Materials

Figures 6.13 to 6.16 shows participants' information-processing activities and interactions in relation to processes used. Figure 6.13 shows the amount of time participants spent in overlapping information-processing activities using the current interface. Figure 6.14 shows the amount of time participants spent in overlapping information-processing activities using the new interface. Figure 6.15 show the amount of time participants spent in

overlapping interactions using the current Interface. Figure 6.16 show the amount of time participants spent in overlapping interactions using the new Interface.

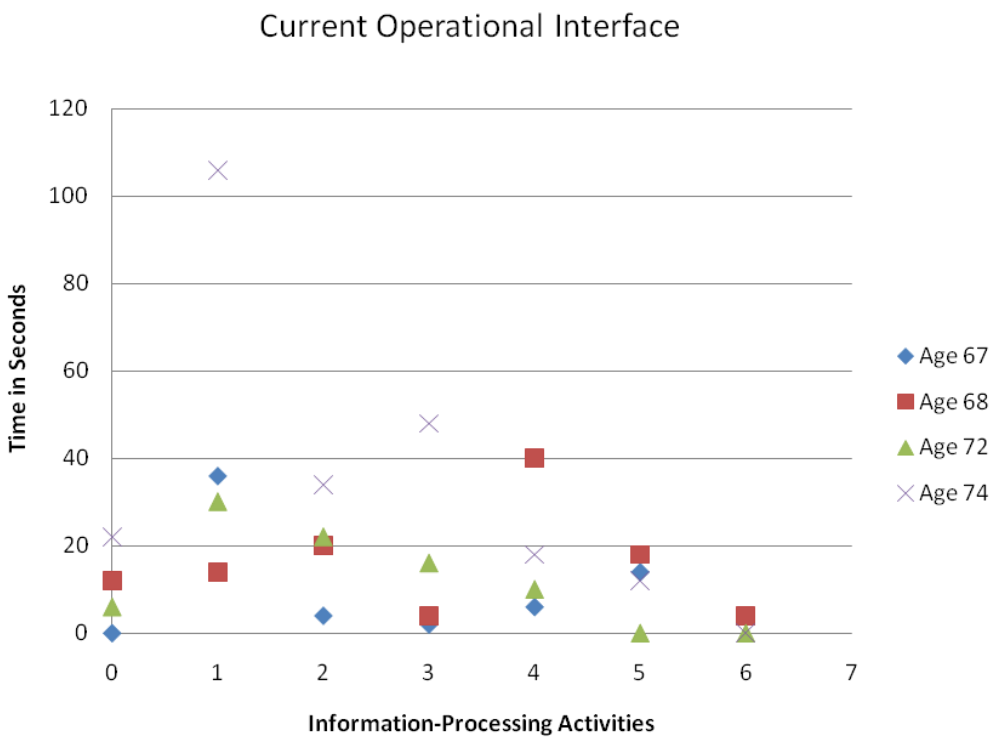


Figure 6.13 Amount of Time Participants Spent in Overlapping Information-Processing Activities using the Current Interface

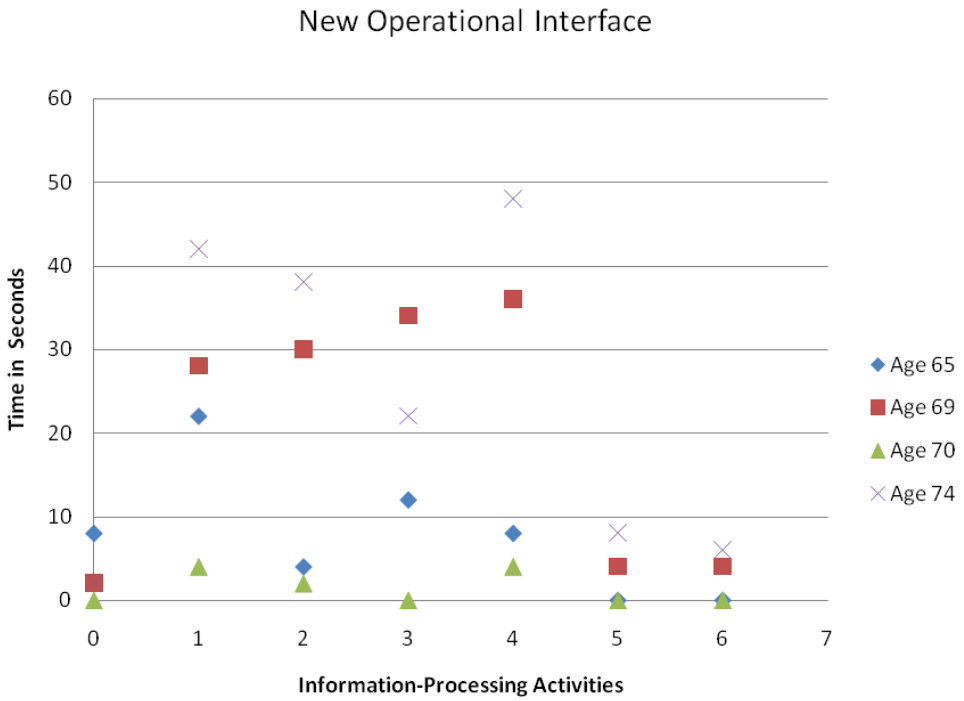


Figure 6.14 Amount of Time Participants Spent in Overlapping Information-Processing Activities using the New Interface

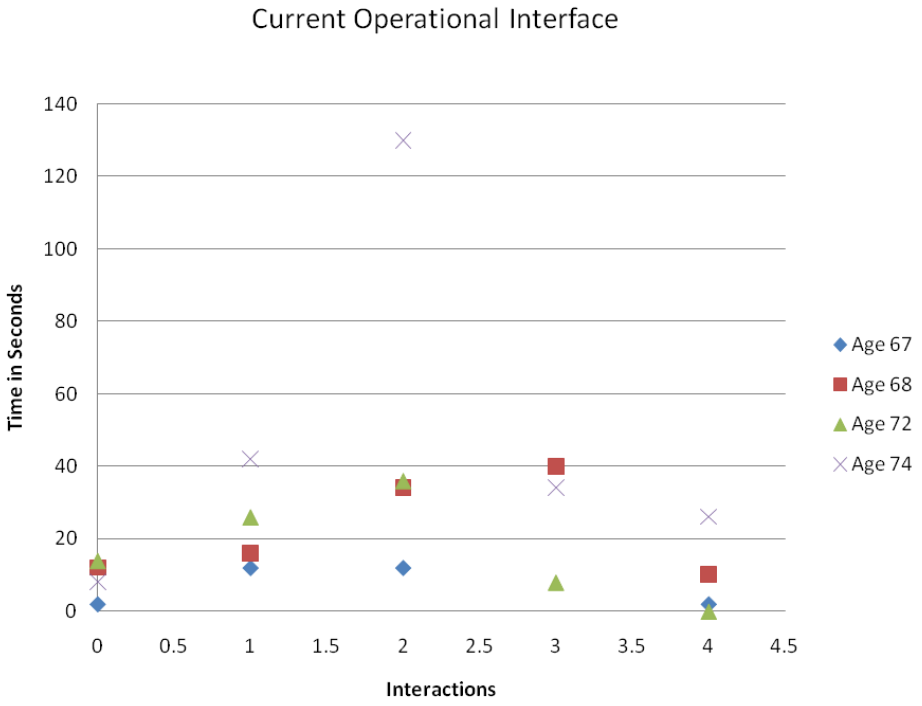


Figure 6.15 Amount of Time Participants Spent in Overlapping Interactions using the Current Interface

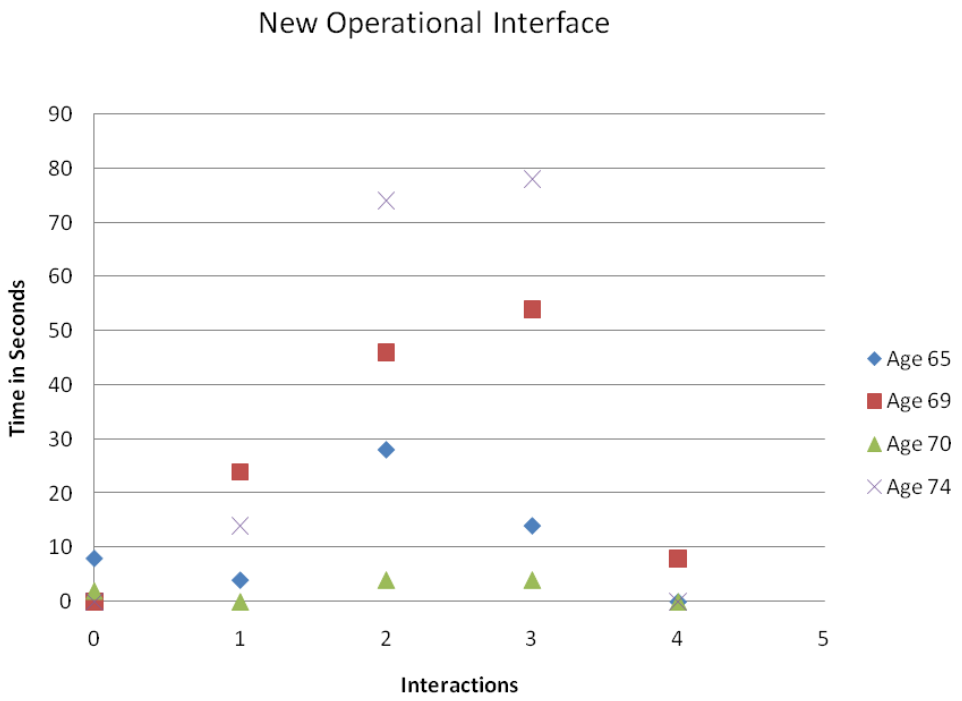


Figure 6.16 Amount of Time Participants Spent in Overlapping Interactions using the New Interface

Despite experienced difficulties, several participants demonstrated a good level of abilities in information-processing activities and interactions. Participants used information on operational interfaces and instructional materials.

6.2.2 Evaluations of Information-Processing Activities

Figures 6.17 to 6.19 shows the information-processing activities used by participants in the task. Figure 6.17 shows the amount of time participants spent in information-processing activities categories. Figure 6.18 shows the percentage of time non-successful participants spent in information-processing domains. Figure 6.19 shows the percentage of time successful participants spent in information-processing domains.

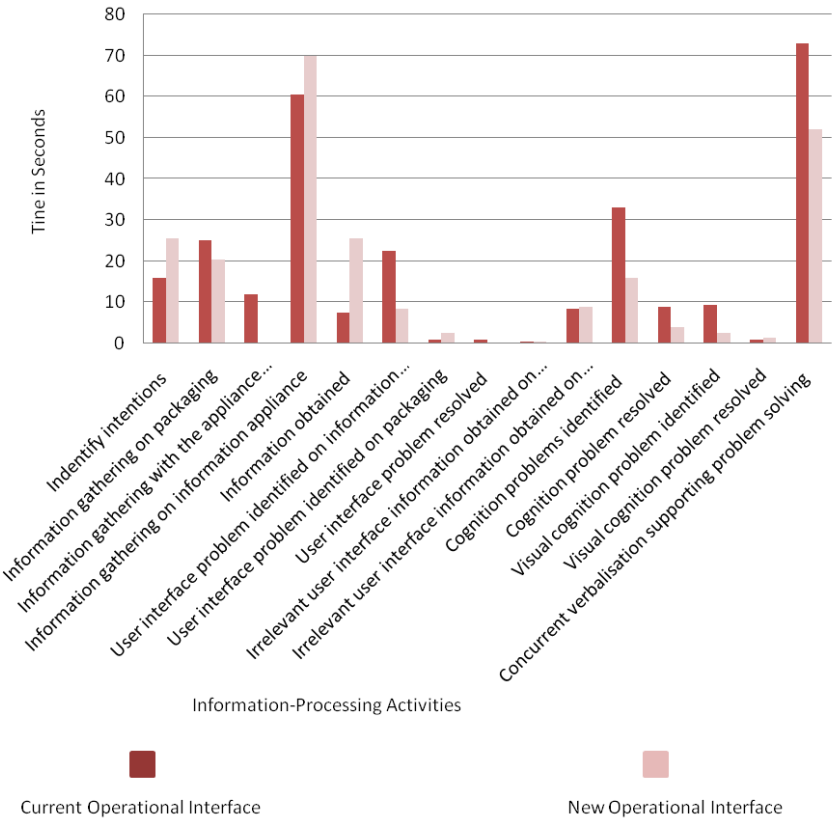


Figure 6.17 Amount of Time Participants Spent in Information-Processing Activities Categories

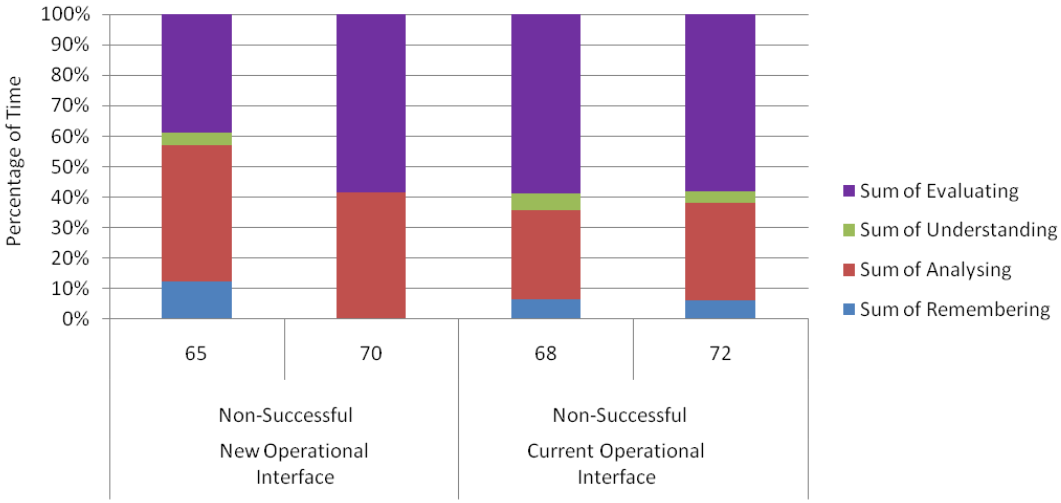


Figure 6.18 Percentage of Time Non-Successful Participants Spent in Information-Processing Domains

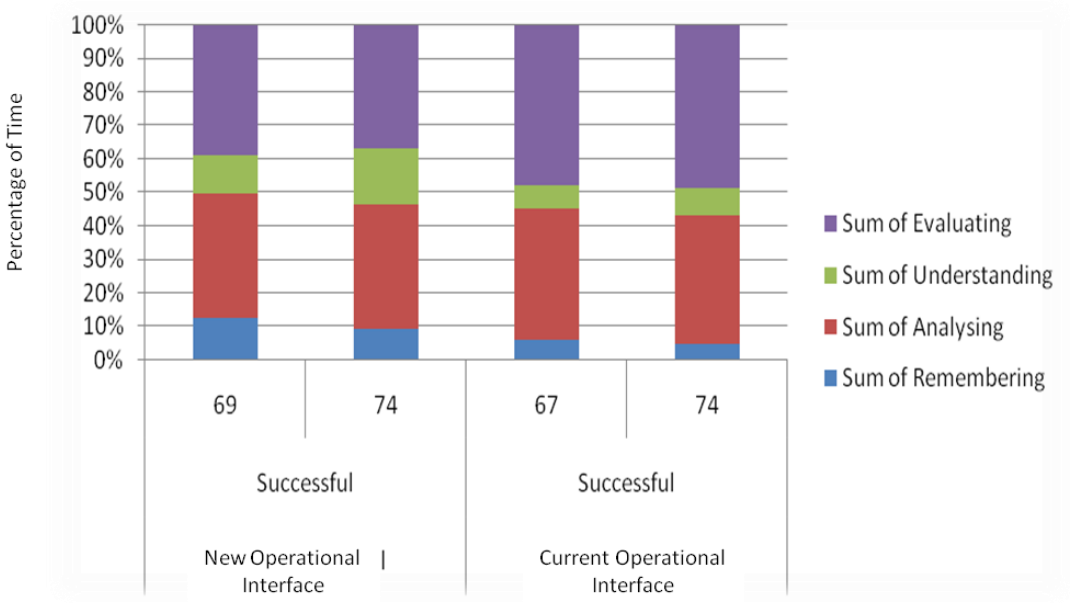


Figure 6.19 Percentage of Time Successful Participants Spent in Information-Processing Domains

Results suggested that the new interface influenced participants' information-processing abilities and concentration level positively. In addition, results suggested that reading and processing information was easier with the new interface. The finding suggested that visual instructions and information on the new interface were better linked to routine activities and habitual behaviours, this in turn, positively influenced information-processing. Participants monitor the layout and configuration of visual instruction and information on interfaces. The finding suggested that visual instructions and information are more favourable to participants when they are in operational sequence. Less interaction breakdowns and focus-shifts occur.

Four key findings about the use of information design were identified: motivators; integration; realtors; and discriminators. For example,

participants analysed and evaluated information in sequential series and used real-life operational procedures. Participants made decisions based on linking visual instructions on operational interfaces and instructional materials. Participants' information-processing and interactions mirrors the activities and habitual behaviours of activities of daily living.

Participants' individual information-processing activities and interactions were distinctive, however, searching and gathering information were key to participants' processes. Information influenced the activities, procedures and operational sequences used by participants. Findings suggested that visual and auditory information presented in sequential series were beneficial. In addition, combining visual and auditory information had positive effect on participants' information-processing activities and interactions**.** Noticeable findings were the overlapping transitions amongst information-processing activities and interactions. Participants demonstrated a high level of ability to process different information-processing activities and interactions simultaneously. Variability in overlapping transition amongst information-processing activities and interactions was not attributed to participants' age. The study found that four information-processing activities domains were key to the task: analysing, evaluating, understanding and remembering. Results presented evidence of a taxonomy of participants' information-processing activities. Four information-processing activities domains are predominant in how participants' information-processing activities when using operational interfaces for domestics appliances, such as a microwave.

Three distinctive information-processing activities were identified: gathering, obtaining information, and resolving problems using concurrent verbalisation. Affective learning included problem scoping and using information to develop alternative actions and processes. Results in Figures 6.18 and 6.19 indicated that participants paid attention to details and elements of information which can be accessed and played back immediately to perform the task. Findings suggest that participants run into difficulties with words, text, symbol signs and number associations.

Two key characteristics of participants' intervention strategy include differentiation between irrelevant and relevant information. Being able to perform the task and resolve issues depends on a number of information-processing skills. An important information-processing skill is the ability to recognize irrelevant and relevant information in sequence and visualize information. The extensive use of concurrent verbalisation suggests that participants use information to create a task sequence to formulate the process to complete the task. This eventually leads to the ability to remember task purpose, process and a formula for operations. Figure 6.18 and Figure 6.19 show the in ways in which participants' responded to the task and operational issues.

A key finding from this experiment was that participants relied on information gathering on the microwave oven interface and ready meal packaging for instructions and directions. Problem scoping formed the greatest proportion of interactions and participants became aware of information inconsistencies between information sources. Four key factors in the use of information for improvisation and information seeking interventions were identified:

motivators, integrators, relaters and discriminators. For example, participants maintained a focus on these and concentrated on information on the appliance, the new user interface, instruction manual and ready meal packaging. The visual information was used to track information to strengthen working memory. Participants' information-processing activities and interactions were distinctive, searching and gathering information was key to performing the task.

Figures 6.18 to 6.19 show the participants' information-processing activities, interactions and impediments to workflow. Findings suggested that participants continuously linked visual instructions and monitored the layout and configuration of visual instructions and information. On first analysis, interaction breakdowns (where the task is stalled) and focus shifts (where a participant is distracted from the task) appear to have negative effects on performing the task. However, insights on participants' information-processing activities suggest that during interaction breakdowns and focus-shifts participants analyse, evaluate, understand and remember information using these four intervention strategy. Findings suggested interaction breakdowns and focus-shifts are not impediments to workflow, but are required in information-processing.

Noticeable findings were that multiple activities of information-processing and interactions demonstrate a high level of ability to process information simultaneously. Being able to solve context-dependent procedure requires activities and interactions to be built on one another like building blocks. The ability to recognize and reproduce operations is the foundation for the next block. From this position, participants were able to build up and store

information about the context and procedure by creating a number of sequences to solve problems and perform the task.

Findings suggest that participants experienced difficulties when making connections between information on the current microwave oven interface and ready meal packaging. The arrangement of information did not reflect a sequential process or the activities involved in performing the task in daily living. In addition, the information resources relied on by the participants were inconsistent. The study found that participants' attention levels, cognitive and perceptual load were affected more by irrelevant and relevant information on the current microwave oven user interface and ready meal packaging. Results indicate that multiple information-processing activities and interactions were key aspects of performing the task.

6.2.3 Evaluations of Interactions

Figures 6.20 to 6.22 shows the interactions used by participants in the task. Figure 6.20 shows the amount of time participants spent in interaction categories. Figure 6.21 shows the percentage of time non-successful participants spent in interaction domains. Figure 6.22 shows the percentage of time successful participants spent in interaction domains.

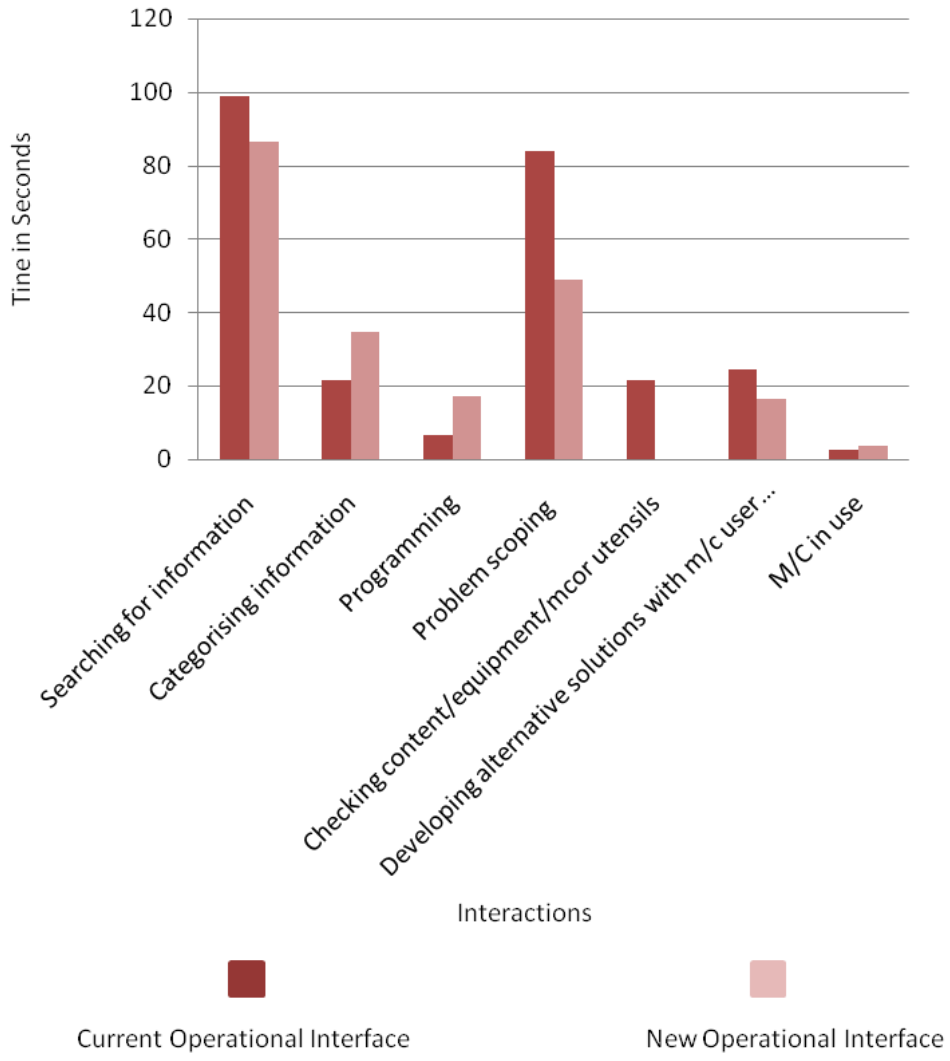


Figure 6.20 Amount of Time Participants Spent in Interaction Categories

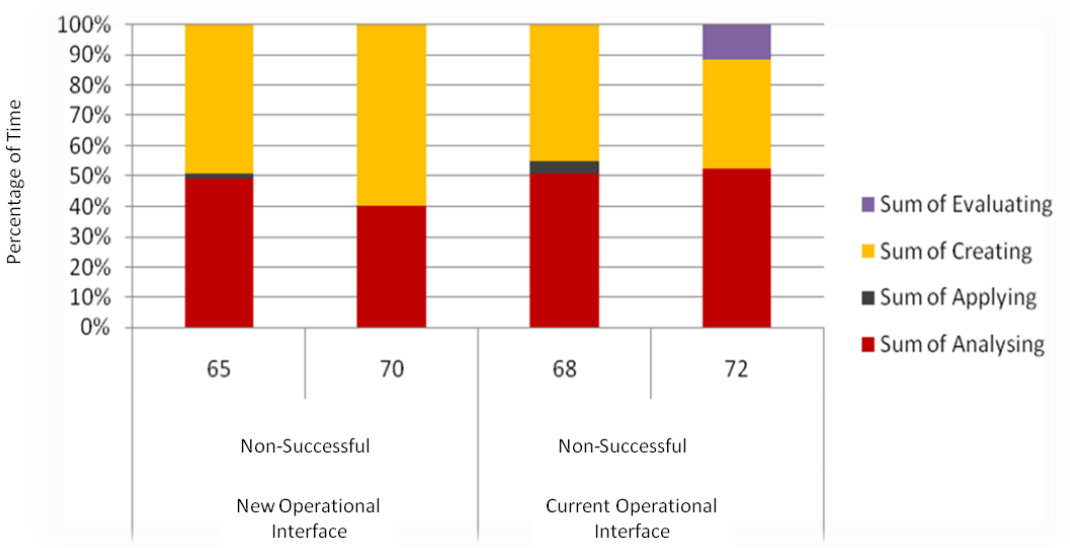


Figure 6.21 Percentage of Time Non-Successful Participants Spent in Interaction Domains

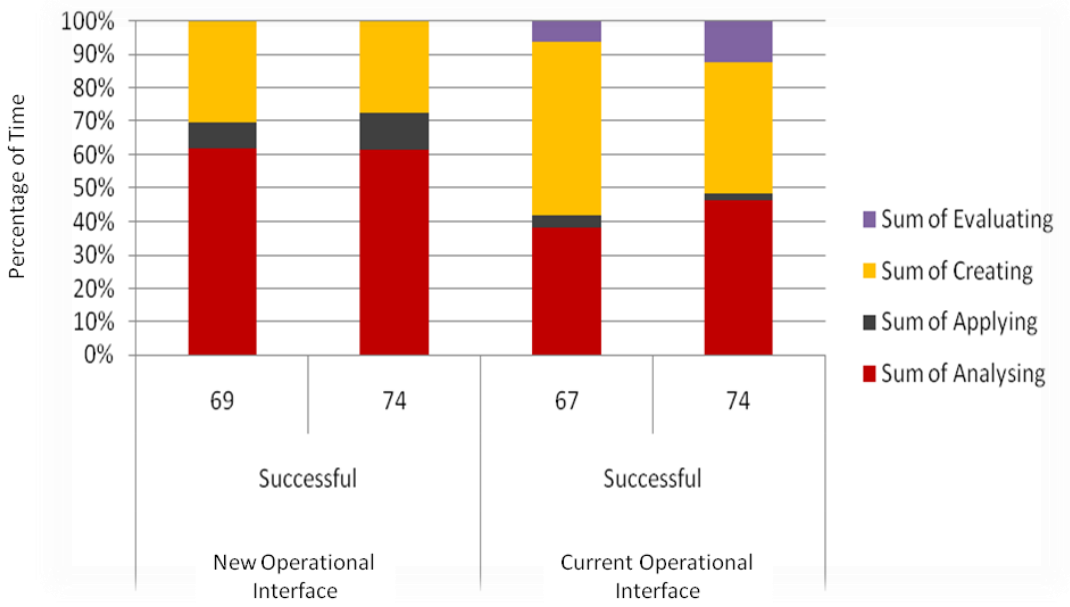


Figure 6.22 Percentage of Time Successful Participants Spent in Interaction Domains

The study found that four interaction domains were key to the task: analysing, evaluating, applying and creating. Results presented evidence of a taxonomy of participants' interactions. Four interactions domains were predominate in how participants' interact when using operational interfaces for domestics appliances, such as a microwave.

6.3.4 Evaluations of Impediments to Workflow Activity

Figure 6.23 shows the amount of time participants spent in impediments to workflow activities.

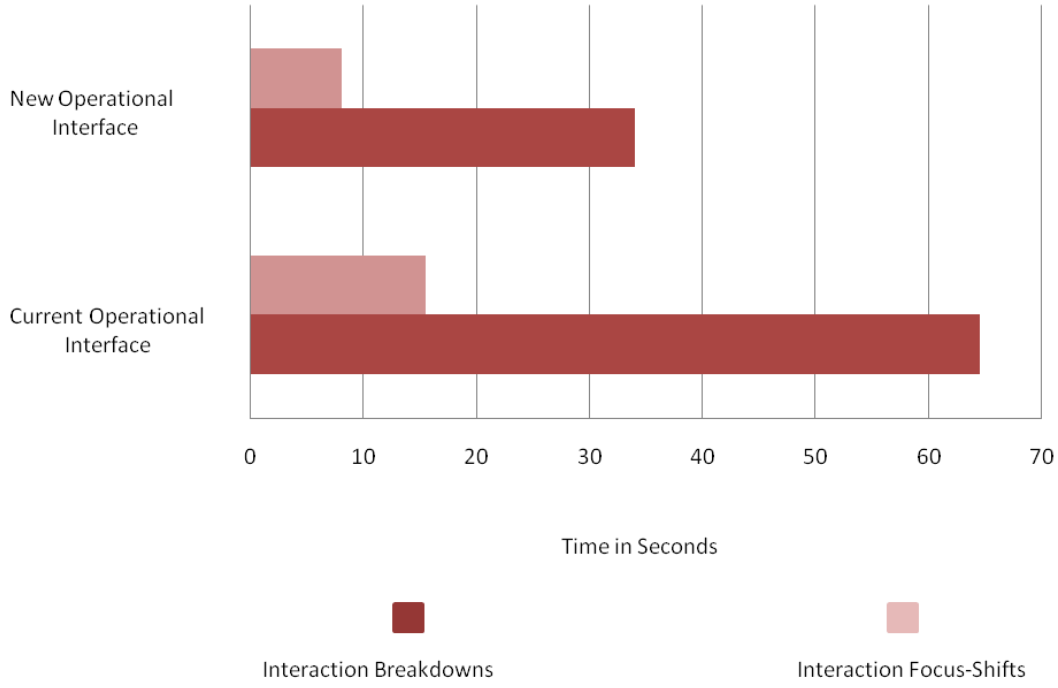


Figure 6.23 Amount of Time Participants Spent in Impediments to Workflow Activities

Results suggested that participants experience interaction breakdown (where the task is stalled) and focus shift (where a participant is distracted from the task). Results suggested that interaction breakdowns and focus-shifts are experienced by all participants using both interfaces. On first analysis, interaction breakdowns and focus-shift appear to have negative effect on the task. However, data in Figures 6.17 to 6.19 provided insights on participants' information-processing activates. The study findings suggested that during interaction breakdowns and focus-shifts participants analysing, evaluating, understanding and remembering instruction and information. The study findings suggested interaction breakdowns and focus-shift are not negative, but are required in information-process.

6.4 Discussion

Results suggested that the new interface enabled natural process. In addition, the habitual behaviours involved information-processing activities domain of analysing, evaluating, understanding and remembering. In addition, interaction domains of analysing, evaluating, applying and creating. Overlapping transitions amongst information-processing activities and interactions were key findings. Comparisons of overlapping transitions amongst information-processing activities and interaction domains showed poor information-processing was not attributed to participants' age.

Overlapping transitions amongst information-processing activities and interactions were a key finding. Participants' information-processing tended to align information on interfaces and instructional materials. The interesting divergence between Lindqvist & Borell (2011) and this study is that this finding suggested that information design on operational interfaces have the

potential to bring about positive changes in information-processing. Interface characteristics can be used to support the routines by introducing, maintaining, reinforcing or regaining valuable insight on activities. In addition, the study found that suggested visual and auditory feedback integrated into information design can facilities information-processing.

Parker (2011) argues that knowledge of the activities, action and operations used in users' process could be used to improved use centred design. This study found that knowledge acquired in the process of participants' activities are required for next generation information appliances. The study finding suggested that the coding can be used to identify participants' operational sequences and functional language. These have the potential to be used as methods to connect activities, actions and operations. An important finding of this study is that information on instructional materials, such as ready packaging and manual could be considered a factor in non-successful operations with appliances. Results provide evidence to reinforce the use of visual and auditory information on operational interfaces.

Unlike Malinowsky et al. (2010) and Rosenberg's (2009) study, this study found that older participants are not more likely to have decreased ability to use operational interfaces on domestic information-processing appliances. Result of this study suggested that information design decreases participants' abilities, thus, information design can have disabling consequences on the activities of daily living. The ability to manage the information is an important factor to consider when assessing the functional and usability of operational interfaces. In addition, information-processing strategies of participants suggested that irrelevant information affects

participants' information-processing. Similarly to Davenport et al. (2012) this study found that there are inconsistency on operational interfaces. However, this study found that there are inconsistency in information design. The finding suggested that there is a need for a deeper and broader understanding of factors affecting the quality of information used on operational interfaces and instructional materials.

This study found pattern of behaviours in information-processing activities (analysing, evaluating, understanding and remembering) and pattern of behaviours in four interaction (analysing, evaluating, applying and creating). This study concurs with Nycyk & Redsell (2010) study. Indeed, participants were under cognitive and perceptual pressures to use operational interface, however, many participants tended not to be reluctant to learn how to use the interface. In fact, several participants were willing to learn about the interfaces using the manual and ready meal packaging. The findings contributes to understandings of the types of practices older adults because it identified that participants were ready to learn about the process and task.

Schroeder & Ziefle's (2008) study indicated that icons in information on appliances do not obeys ergonomic rules. This study showed how the process of combining functional level language with routine and habitual behaviours experienced in activities of daily living can facilitate information-processing activities and interactions. Jones & Sarter (2008) argued that breakdowns in human-machine interaction are the result of poor feedback, inadequate mental models of the users and the high degree of coupling and complexity on operational interfaces. The study found that interaction breakdowns and focus-shift are essential information-processing, they are a

natural part of the interaction between participants and domestic information-processing appliances.

6.5 Summary

Evaluations of the new and current interfaces suggested that the following features facilitated better participants' interactions and information processing activities.

- Displaying words, phrases, symbols and imagery in sequential series.
- Displaying the whole information-processing task in full on the operational interface.
- Constraining dynamic actions and operations.
- Displaying words, phrases, symbols and imagery based on functional level language used in the context of the activity.
- Using visual and auditory instructions.
- Allowing participants to access visual and auditory instructions on demand.
- Discriminating between operational interface features using defined categories.
- Using categories of information.
- Using information continuum.
- Using touch modalities such as gesture.
- Using a linear operational series.
- Using animated and dynamic operational interface features.

The study found that four participants' (four participants' (two participants using each interfaces) attention levels, cognitive load and perceptual load

were positively affected by the new interface design. The study findings suggested that overlapping information-processing activities and interactions were a key aspects of all participants' use of operational interfaces. Information-processing activities codes of analysing, evaluating, understanding and remembering, in addition, interaction codes of analysing, evaluating, applying and creating were key aspects of all participants' use of operational interfaces

Descriptions of operational procedures and operational sequences were identified. The study found that participants made decisions based on information. In addition, the operational interface was more accessible when the information design on the operational interface mirrored the activities and habitual behaviours of heating food in a real-world context.

The study found that participants' foundation knowledge on a task and functional level language influenced actions. The finding suggested that participants' knowledge of the task in a real-world context determined interactions and information-processing activities.

Chapter 7
Conclusions & Future Work

The aim of the research reported in this thesis was to explore approaches for supporting independent living through the design of operational interfaces that mirror the real-life processes of operational procedures. To conduct the research, twelve participants (aged over 55 and living independently) were observed carrying out two activities of daily living: washing white cotton bedding in a washing machine, and heating a ready meal in a microwave oven. The observations gathered information about participants' processes, appliance design and operational interface issues. In addition, characteristics of participants' interactions and information-processing activities using domestic information-processing appliances, and instructions associated.

Observations of the microwave oven were used to learn about impediments to workflow activities, participants' information-processing activities and information-processing acquisition behaviours. The research study found that there were many issues related to current operational interface designs, for example, participants' inability to understand, recognise and interpret information on operational interfaces. In addition, it was identified that these issues were, in part, because of limited connections between information on operational interfaces and associated instructional materials. The study found that habitual behaviours demonstrated in participants' routine activities tended not to be used in information design on operational interfaces.

Finally, instructions and information on operational interfaces and instructional materials were difficult to follow because they tended not to present information in sequential order.

7.1 Discussion with Respect to the Research Objectives

In this section, the contributions to knowledge with respect to research objectives are presented.

1. Determine ways in which designers respond to the changing needs of older adults in the design of operational interfaces on domestic information-processing appliances through a review of the literature.

User centred design, human centred design and inclusive design are commonly used methods in the design of consumer products for specific populations such as older adults. Evidence of their effectiveness can be seen in mass produced products such as the Oxo Good Grip product range. However, the design of these products tends to concentrate on ergonomic aspects that improve usability. Studies such as Wilson et al. (2009) devote attention to design solutions that compensates for specific sensory, motor and visual difficulties in related to the ageing process. These methods are less well suited to the design of domestic information-processing appliances where a key aspect for users is information-processing.

A limited number of user centred design research studies relate to older adults' attention levels, concentration, perceptual load, cognitive load and word comprehension using operational interfaces on domestic information-processing appliances. Moreover, inclusive and user centred design studies focus on ergonomic issues. For example, Malinowsky et al. (2010) and Rodriguez (2012) recommend that designers resolve operational interface

issues by considering how older adults use operational interfaces. They advocate that designers observe interactions and information-processing activities to understand user-product interactions.

Results of an early study carried out in this research suggested participants experienced difficulties when trying to make connections between information on operational interfaces and associated instructional materials. It was concluded that designers could respond to the changing needs of older adults in two ways:

a) arrange the information on operational interfaces to reflect the sequential process of the activity of daily living; and
b) make the information on operational interfaces and associated instructional materials consistent with each other.

2. Identify operational interface design goals through observations of older adults using operational interfaces on domestic information-processing appliances to carry out activities of daily living.

Two empirical studies with two participants, one using a washing machine and the other using a microwave oven, were carried out. Two key design goals were identified. Firstly, an information continuum should be used to present the full operational sequence (on the operational interface) in connection with the activities of daily living and the processes used in the task. Secondly, information categories should be used to group the processes used in the task, for example, cook cycle, temperature and time. In this way, all aspects of the operation on the appliance could be understood, recognised and interpreted.

3. Establish evaluative performance criteria to enable the design, development and assessment of an alternative domestic information-processing appliances operational interface.

Characteristics of interaction with microwave oven and the washing machine were identified. Twelve evaluative performance criteria for operational interfaces for participants were defined and associated with requirements for a new operational interface design. The criteria and associated with requirements are summarised in Table 7.1

Table 7.1 Microwave Oven & Washing Machine Evaluative Performance Criteria & Associated Design Requirements (reproduced from Figure 4.6)

Evaluative Performance Criteria	Associated Design Requirements
Purposeful	The operational interface should allow participants to make meaningful connections between the information-processing task, activities, its goals and information used
Size of Visual Instructions Appropriate for Use	Ensure that participants can read the operational interface features from a minimum distance of 500mm. Ensure that participants can reach and touch the operational interface features from a normal operating position. Positioned operational interface features along the horizontal line of sight between zero and 30 degrees.
Standardised Elements	Use consistent instructions and information on operational interfaces
Responsiveness to Errors	Use visual and auditory instructions on operational interfaces
Functional Grouping	Place operational interface features in a linear operational series-constrain the series of actions if necessary
Sequential Grouping	User functional level language based on operational series based on operational interfaces.
Learnability	Use intuitive words, phrases, symbols and imagery used in early learnt experience of the activity or task
Flexible in Use	Allow participants to tailor actions, operational series and activities
Perceptibility	Use recognisable and understood words, phrases, symbols and imagery
Intelligibility	Use interpretable words, phrases, symbols and imagery
Level of Cognitive Effort	Use sequential series and auditory repetition of words, phrases, symbols and imagery to minimise cognitive overload
Actionability	Use operational series and discriminate between operational interface features

4. Design and develop an alternative operational interface for a domestic information-processing appliance and evaluate how its effects older adults' interactions.

The final design of the new operational interfaces is presented and evaluated in Chapter 6 and details of the design development process are reported in Appendix A. The new design was created to respond to the design goals identified in Objective 2. The new operational interface and the ways in which it addresses the design goals and requirements in Objective 3 are summarised in Figure 7.1

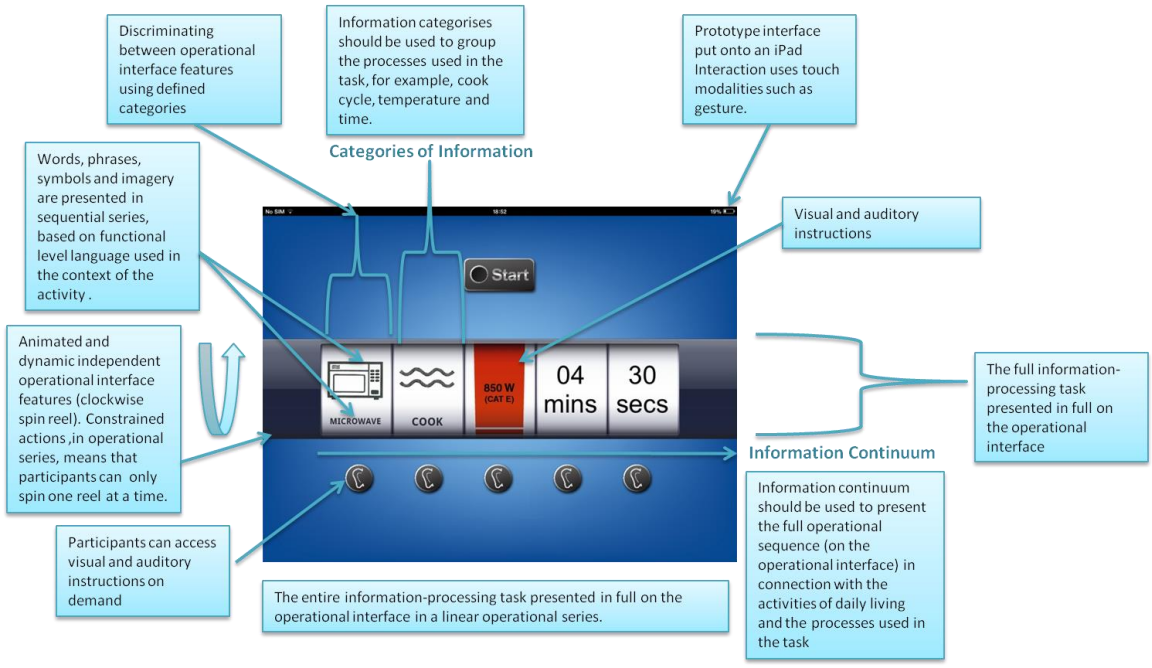


Figure 7.1 New Operational Interface on iPad App & the Design Goals Summarised ((reproduced from Figure 6.1, annotated with key design features (See Appendix F))

5. Establish a framework to enable the assessment of the interactions and information-processing activities in the use of operational interfaces.

A framework, in the form of a coding scheme, for use in the assessment of participants' interactions and information-processing activities when using domestic information-processing appliances was established. Video footage of the microwave oven was used to produce the coding scheme. Three coding categories were derived: eighteen information-processing activity codes, six interactions codes and two impediments to workflow activity codes. Chapter 6 reports the use of the coding scheme to evaluate two operational interface designs (new and current microwave oven) in the context of the activities of daily living. Descriptions of participants' interactions and information-processing activities were defined. Sequences and interactions used in real-life operational procedures were analysed and evaluated.

6. Evaluate the framework by using it to analyse the effects that information-processing has on older adult interactions with domestic information-processing appliances.

Two empirical studies with eight participants, four using the new microwave oven interface (see Appendix A) and the others using a current microwave oven interface were carried out. Comparisons were made between participants using the two interfaces. Data was analysed using the following as criteria:

- Information-processing requirements;

- Operational procedures;
- Impediments to workflow activity;
- Operational procedural domains;
- Information-processing skills requirements;
- Overlapping transitions among operational procedural domains; and
- Overlapping transitions among information-processing skills requirements.

The study found that four participants' (two participants using each interfaces) attention levels, cognitive load and perceptual load were positively affected by the new interface design. The study found that overlapping information-processing activities and interactions were key aspects of all participants' use of operational interfaces. Information-processing activities codes of analysing, evaluating, understanding and remembering, in addition, interaction codes of analysing, evaluating, applying and creating were key aspects of all participants' interactions using operational interfaces on the domestic information-processing appliances.

Participants' interactions and information-processing activities mirrored the activities and habitual behaviours of heating a meal in a real-world context. Evaluations of participants' information-processing activities indicated that talking through operational interface issues was an important aspect of information-processing. Four participants showed an ability to resolve operational interface issues. This was done by referring to information in operational sequence. The study identified the importance of participants' foundation knowledge (task and functional level language) which was used to influence actions. The findings suggested that participants' knowledge of

the task in a real-world context determined interactions and the information-processing activities. Of particular interest, was the fact that the coding scheme could be used to define participants' conscious and unconscious interactions and information-processing activities.

7.2 Contribution to Knowledge Made

The aim of this research was to explore information-processing activities and interactions of older adults when using domestic appliances with a view to improving the design of user interfaces on such appliances. This was achieved by investigating older adults' experiences and perceptions of information-processing activities and interactions when performing tasks with domestic information-processing appliances in conjunction with information such as appliance user manuals and ready meal packaging.

The overarching research question addressed by the research was,

"What types of operational user interface can support older adults with reduced information processing capabilities in using domestic information-processing appliances more effectively?"

Evaluative Performance Criteria for Domestic Information-Processing were established. A coding scheme, based on these criteria was defined and used to collect, analyse and evaluate information-processing activities, interactions and impediments to workflow in a series of experiments.

7.3 Users & Beneficiaries of the Research

The research delivered benefits from a number of perspectives.

- For design practitioners, the research study provides a coding scheme that can be used to identify and analyse information-processing activities and interactions in the context of human activity.

- For occupational therapists, the research study provides insights into ways in which habitual behaviours demonstrated in the routine activities of daily living could be used to inform the design of operational interfaces, visual instructions and information-processing tasks to be completed by older adult with reduced information-processing and interactions.

- For consumer product manufacturers, the research study provides insights on different user interface points used by older adults to inform the performance of a task.

- For social scientists, the research study provides insights into the different information-processing activities and interactions used by older adults. Researchers in the social sciences could use the coding scheme to define activities influencing participants' natural approaches to problem solving such as personal and epistemological reflexivity to identify participants' values and beliefs and the foundations of knowledge and information referencing found in concurrent verbalisation.

- For human computer interaction researchers, specialists and ergonomists, the research study provides understandings of different points of view toward the use of the information in the same human activity.

- For design researchers, the coding scheme provides a method to collect and analyse information-processing activities, interactions and impediments to workflow, and describes older adults' actions, operations

and activities while performing a tasks. This is of particular relevance, to researchers studying conscious and unconscious cognition and interaction, also researchers studying habitual ritual, behaviours and thought patterns of users young and old.

7.4 Validity, Generalisability & Reliability of Results

This research study revealed practical difficulties experienced by older users using domestic information processing appliances. The results highlighted

shortcomings in the design of information on user interfaces and information source materials are the main reason of interaction breakdowns and focus-shifts. Findings suggests these are the reason for multiple transitions amongst interactions and information-processing activities. The findings provide a deeper understanding of the complexities of interactions and information-processing activities. The coded units in three categories of the coding scheme, could be adapted to collect, analyse and evaluate verbal protocol and protocol on the use of other domestic information processing appliances, such as washing machines, where the use of the appliance is based on processes involved a purposeful activity. On the other hand, the research is less applicable to appliances that perform one off functions such as kettles and toaster.

The research study used random variation and ensured sample size was adequate for the study. However, all the participants were European females. As a result, findings may not translate to older adults from other genders or ethnicities. In a further study, observations of a more diverse mix of gender and ethnicity could be carried out. The research involved twelve participants over 55 years-old and three operational interfaces. A larger

number of participants and operational interfaces would have been preferred, however, there needed to be balance between the overall research time frame and the research study design. There are still gaps in knowledge that need to be explored in regards to operational interface design, such as affordance and information. A next step could be to build a stronger evidence base, based on the various types of information on a variety of domestic information-processing appliances.

7.5 Further Work

The premise of the research study was to explore approaches for supporting independent living through the design of operational interfaces. Future work could focus on evaluations and explorations of different operational interface designs using the coding scheme. The question of how older men and ethnic groups in the UK, and internationally use domestic information–processing appliances is a priority for further investigation. Engaging diverse older adults could uncover differing reported experiences. It is possible that older men and people with non-European ethnicities, use different kinds of interactions and information-processing strategies.

Data was collected manually in this research. An opportunity for further development of the research lies in the use of a more automated data collection system. The coding scheme's validation suggested its potential for a further study. The video-recording of participant MW using the microwave oven could be analysed using the coding scheme. The evaluative performance criteria were developed so that product designers could identify the needs of older adults. Future work could focus on evaluations of the performance criteria with product designers. Outcomes could provide greater

insights on ways in which to improve the design of operational interfaces for older adults.

Ageing research in developing countries requires multidisciplinary research. Developing countries urgently need research to help relieve the pressure of an ageing population. Results of this study suggested that older adults living independent in developing countries around the world could be an area for evaluation and exploration. The Caribbean and Latin American's populations are both increasing and ageing. The number of older adults living independently in their homes is expected to increase. Demands on public services, family fragmentation and geographical dispersal of relatives means that older adults in the Caribbean and Latin American are living alone for longer. Initial research could focus on information design, activity and affordances Kaptelinin & Nardi (2012) and Bærentsen & Trettvik (2002), independent living and ageing in the Caribbean and Latin America.

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Appendix A
Approach Used to Design & Developing New Operational Interface For a Microwave Oven

The key aim of this appendix is to summarise the design process used to design led-action research methods to derive an alternative operational interface design for use in the assessment of participants' interactions and information-processing activities.

A.1.1 Design-Led Action Research Approach used to Generate Design Requirements

The research instruments and participants in the experiments are summarised in Table A.1. The appendix gives an overview of the methods used in this study.

Table A.1 Summary of instruments and participants in the development of the new operational interface (reproduced from Table 6.1)

Combinations of participant, appliance and interface used	Research Instruments	
Participants	**User interface**	**Instructional Materials**
VA (female) aged 61	Microwave oven operational interface	Manual and ready meal packaging
FG (female) aged 68		
TC (male) aged 58		

An experimental research process of design-led action research was used. The focus in this section is on the methods used to develop the new operational interface. The research process of design-led action research built on cases drawn from van de Ven's (2007) and van de Ven's (2006). Key steps in the research process are shown in Figure 6.1.

An experimental research process of design-led action research was used. The focus in this section is on the methods used to develop the new operational interface. The research process of design-led action research built on cases drawn from van de Ven's (2007) and van de Ven's (2006). Key steps in the research process are shown.

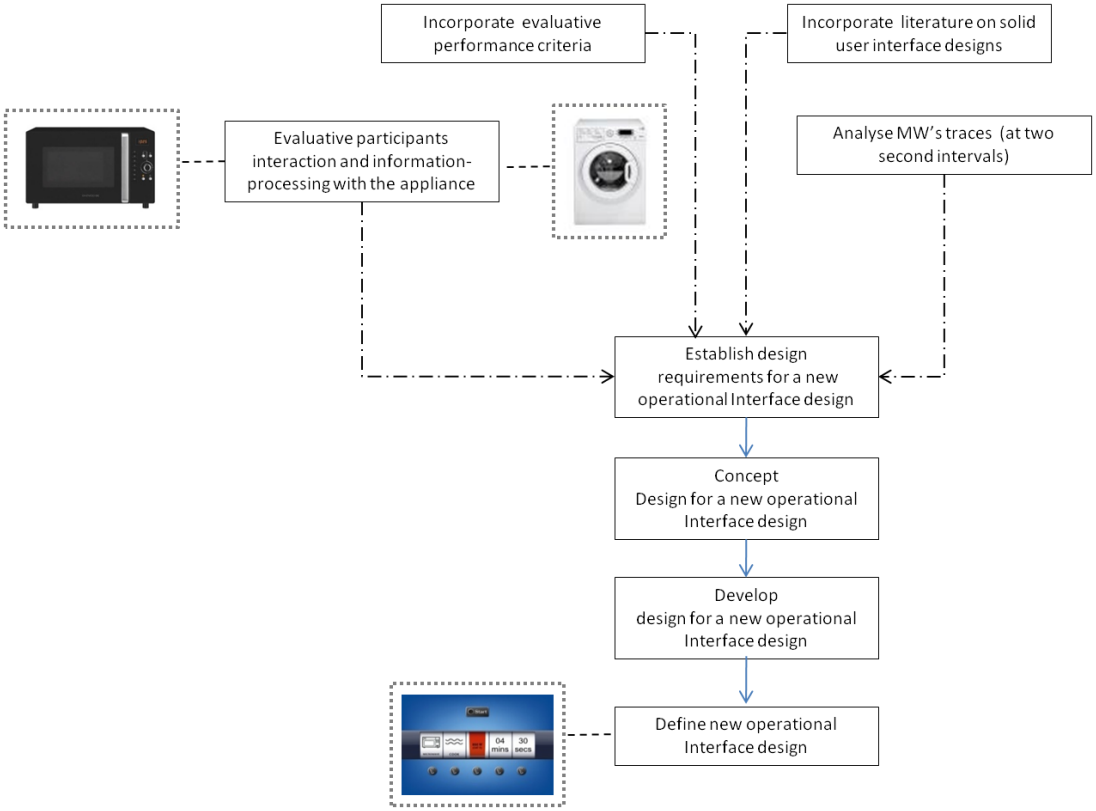


Figure A.1.1 Amount of Time Participants Spent in Impediments to Workflow

The key conclusion from Chapter 5 was that visual instructions and information on the operational interface caused distractions and interruptions to workflow activities. A more detailed understanding of how visual instructions and information could be used to improve the interactions and information-processing activities were needed. This chapter reports results of a study that used action research methods described by Fendt & Kaminska-Labbe (2011) to develop a new operational interface for the microwave oven.

Design concepts were generated using augmented and alternative communication techniques described by Grove's (1990). They were used to facilitate an improved understanding of the use of written visual instructions. This provided a standardised visual communication language for the development of the operational interface. Design concepts were analysed using process-specific lateral interaction methods described by Freeman et al. (2001), Freeman et al. (2002), Freeman et al. (2005) and Freeman et al. (2014). The selected design concept was refined in a series of steps using three users. The final design definition was put into app format onto an IPad. The design was evaluated by the same three users.

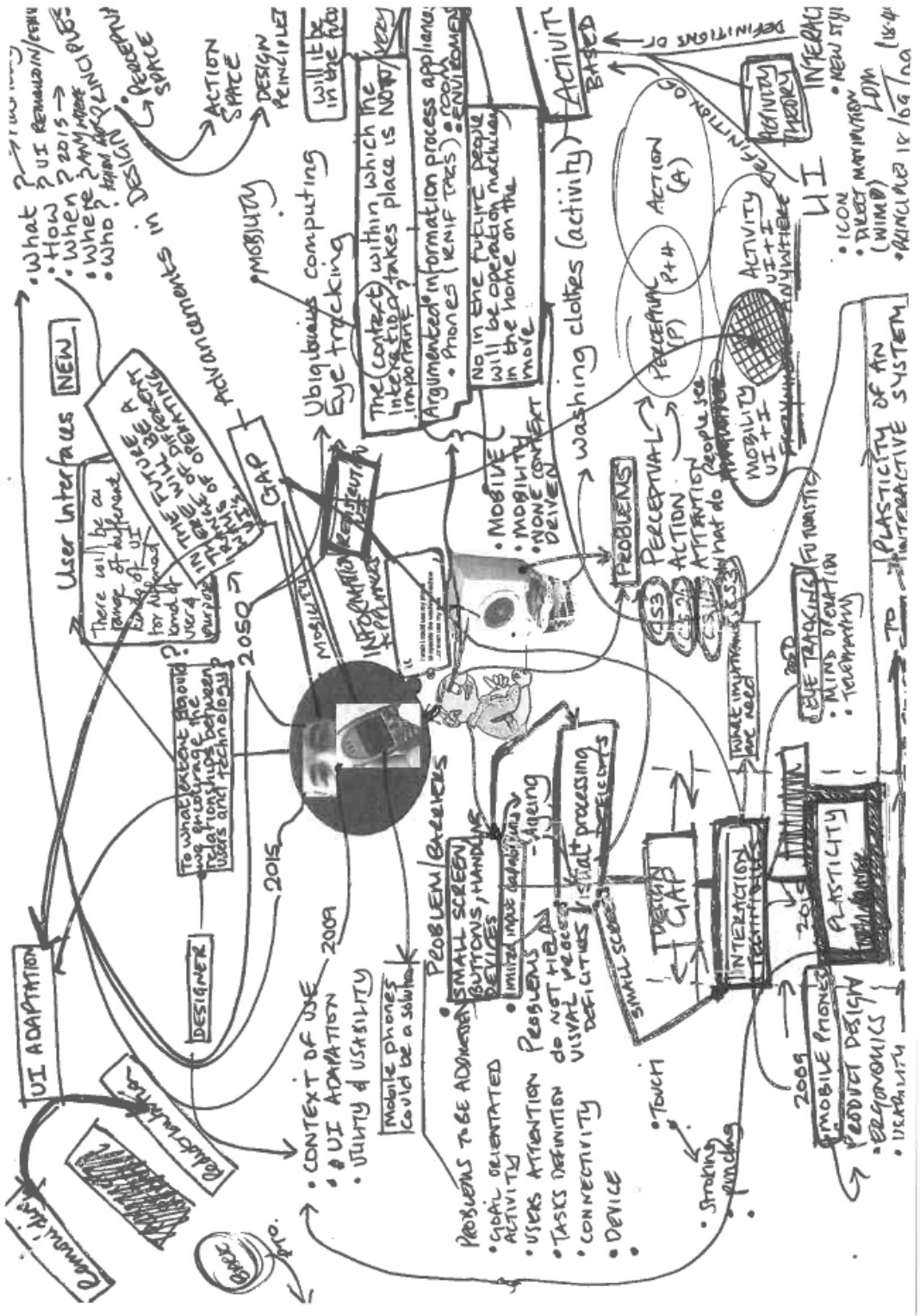
Design requirements were specified based on participants needs and operational interface issues encountered. Design requirements were as follows.

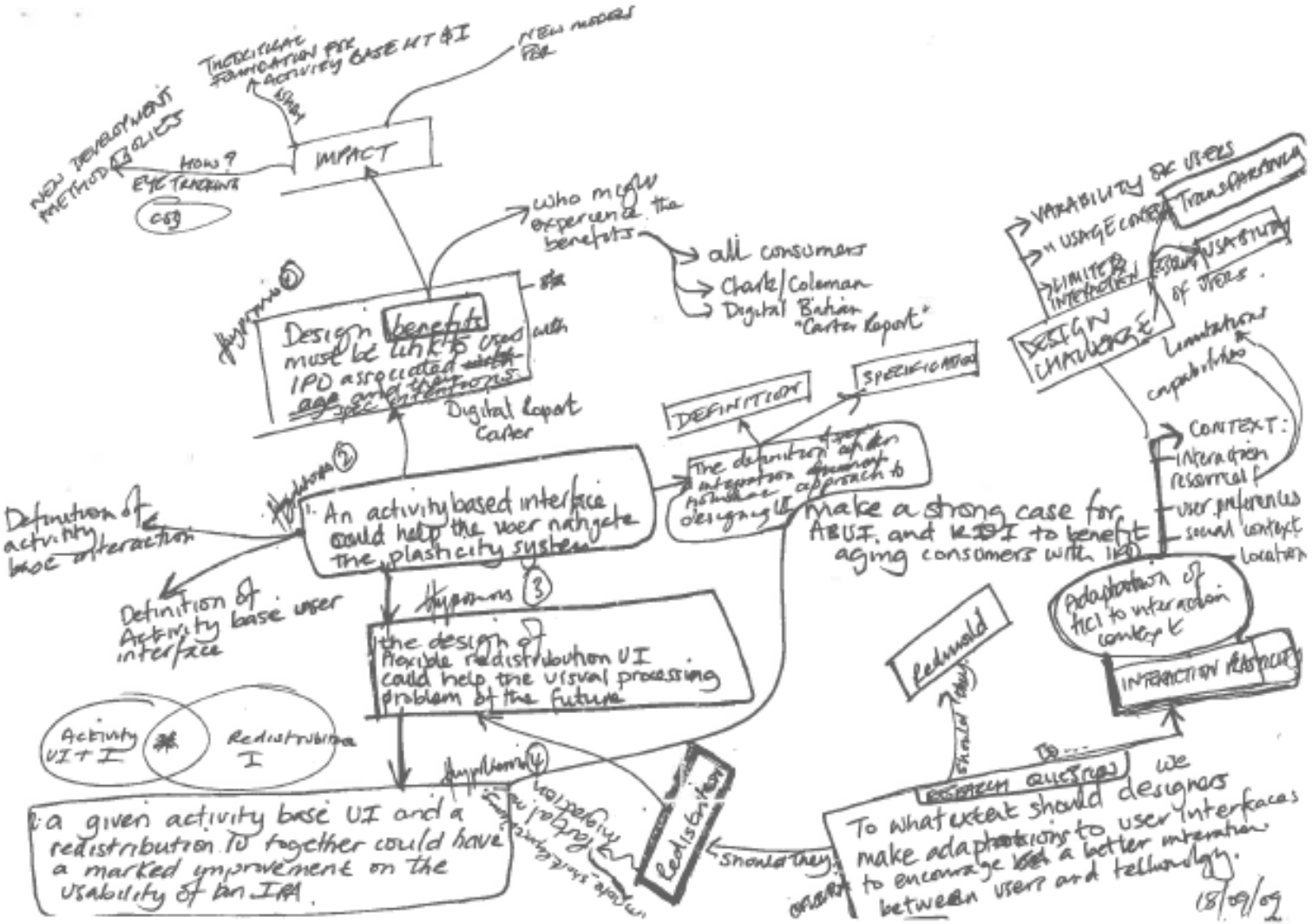
- Displaying words, phrases, symbols and imagery in sequential series.
- Displaying the whole information-processing task in full on the operational interface.
- Constraining dynamic actions and operations.

- Displaying words, phrases, symbols and imagery based on functional level language used in the real world.
- Using visual and auditory instructions.
- Allowing participants to access visual and auditory instructions on demand.
- Discriminating between operational interface features.
- Using categories of information.
- Using information continuum.
- Using touch modalities such as gesture.
- Using a linear operational series.
- Using animated and dynamic operational interface features.

These design requirements were considered necessary and feasible.

A.1.2 Design Concepts

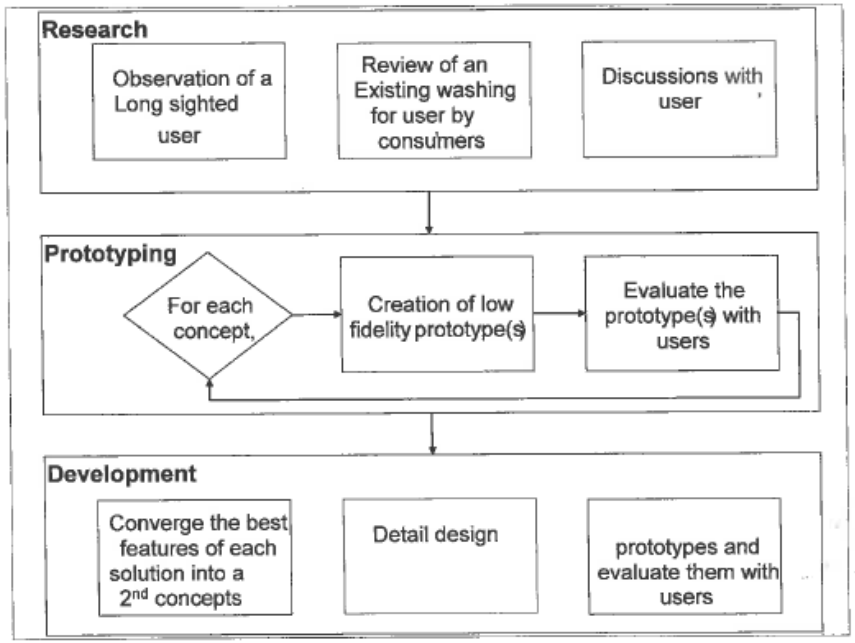



IMPACT
Who might experience the benefits
all consumers
Clarke/Coleman
Digital Britain "Carter Report"
Design benefits must be linked to IPD associated with age and specific interfaces
Digital Report Carter
DEFINITION
SPECIFICATION
DESIGN CHALLENGE
CONTEXT:
Definition of activity base interaction
1. An activity based interface could help the user navigate the plasticity system
Definition of Activity base user interface
make a strong case for ABUI and RDI to benefit aging consumers with IPD
the design of flexible redistribution UI could help the visual processing problem of the future
Activity UI + I
Redistribution I
a given activity base UI and a redistribution together could have a marked improvement on the usability of an IPA.
Redistribution
Feedback
Adaptation of HCI to interaction context
INTERACTION ADAPTATION
To what extent should designers make adaptations to user interfaces to encourage a better interaction between users and technology.
18/09/09

Aim & Objectives of The Case Study

UNIVERSIT

Figure 1: An overview of the design process used

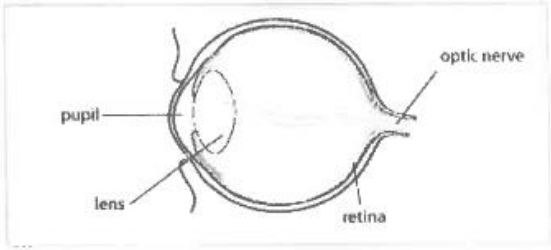


This case study used a washing machine and a participant named Georgetta

Impact of Long Sightedness-Aging Link

UNIVERSITY OF LEEDS

Because of ageing and various eye conditions, the structure and function of the eye can also deteriorate, which can result in **blurred vision**, **central or peripheral loss of visual field**, and **reduced contrast sensitivity**. **Colour blindness** is mainly inherited as a genetic defect, although the **ability to distinguish between blue and green can decrease with age**.



Case Study Methodoiogy

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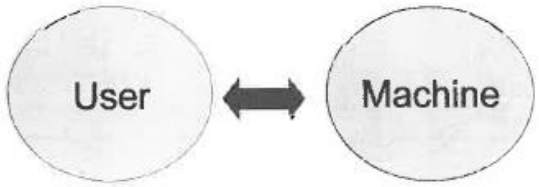


[SEA] situation and context of use
[TA] what is the user doing?
[AT] practice of user

Systems Evaluati
Approach [SEA

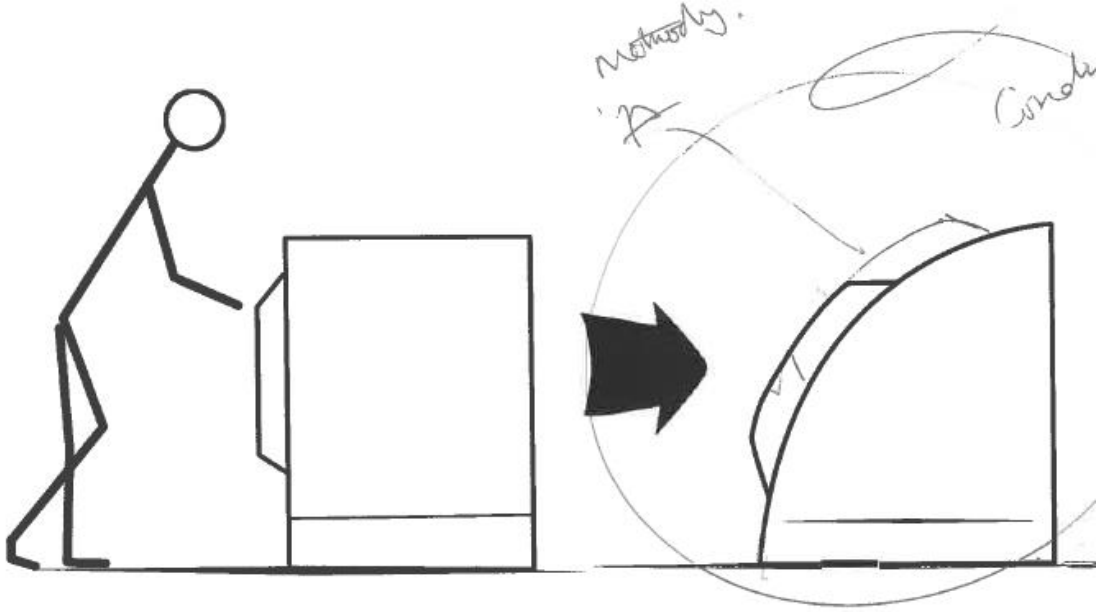
Task Analysis
[TA]

Activity Theory
[AT]

1

Learning System 'Evaluation' Approach [SEA]

UNIVERSITY OF LEE



1

Learning System 'Evaluation' Approach [SEA]

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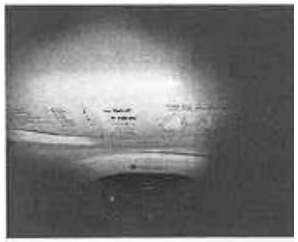
Loss of colour perception

Loss of colour visual acuity

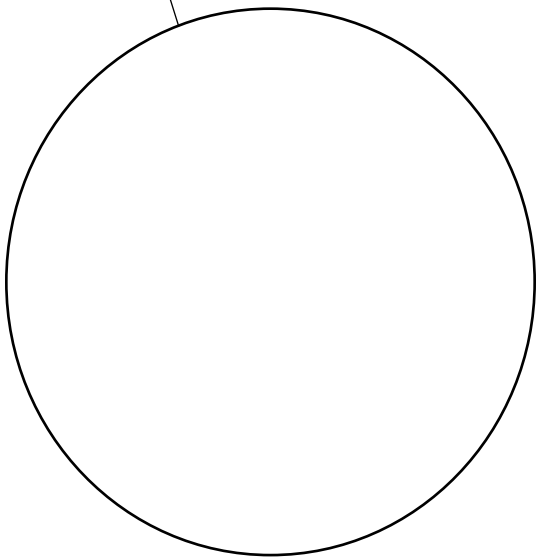


Loss of peripheral vision

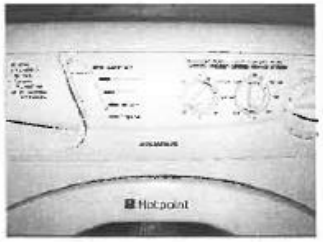
Loss of contract sensitivity

Loss of central field vision

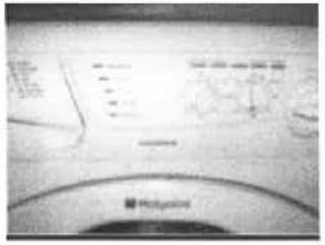
1



Learning System 'Evaluation' Approach [SEA] UNIVER



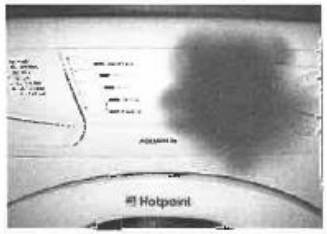
Loss of colour perception



Loss of visual acuity

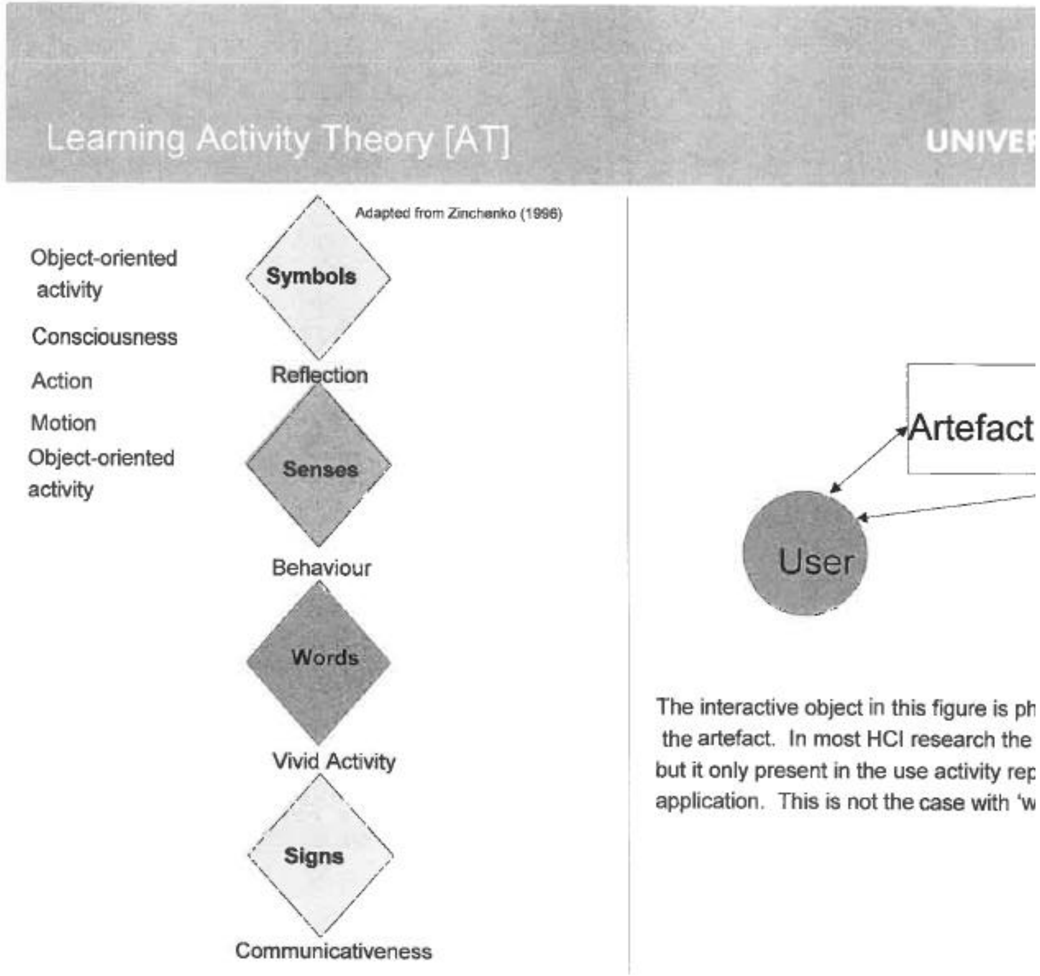
Loss of peripher

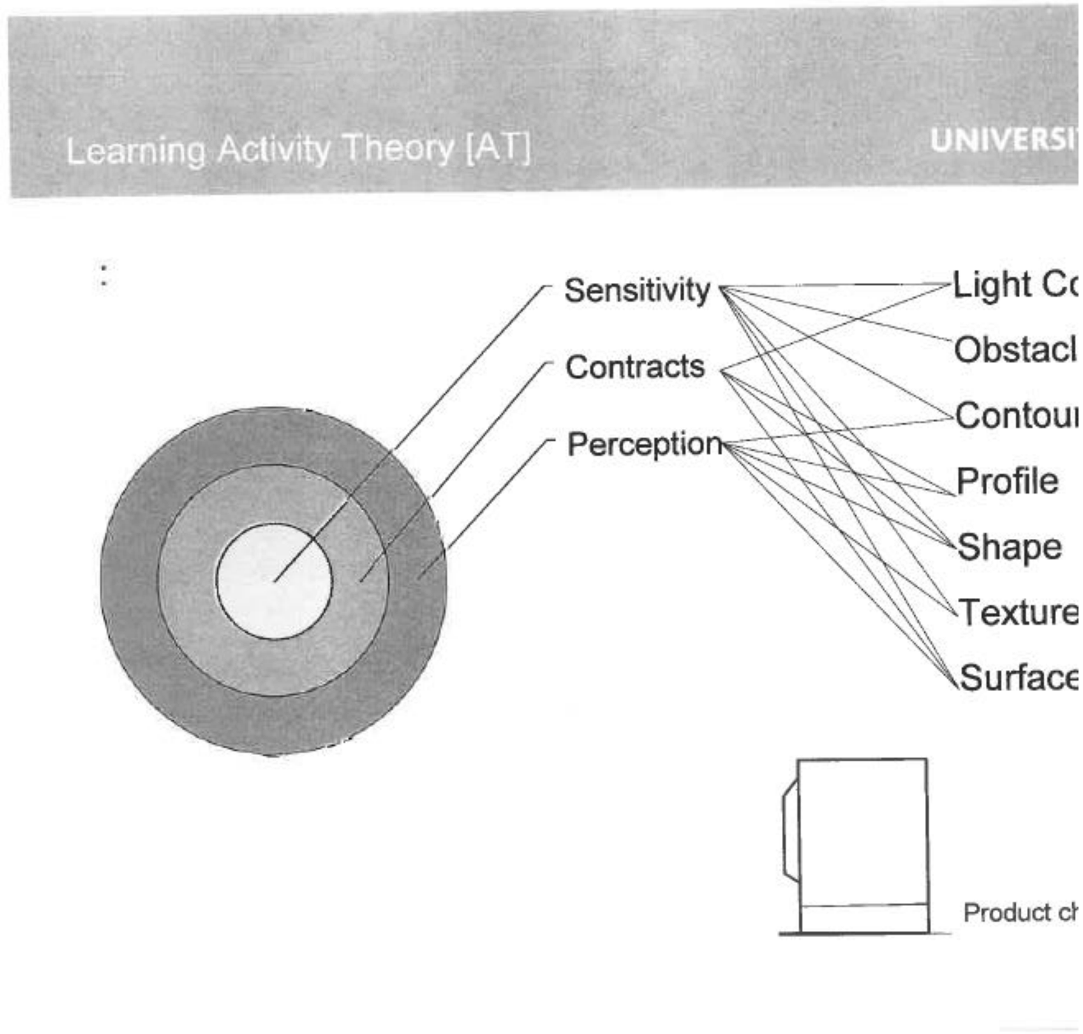
Loss of contract sensitivity



Loss of central field vision

1


Learning Activity Theory [AT]
UNIVE
Adapted from Zinchenko (1996)
Object-oriented activity
Consciousness
Action
Motion
Object-oriented activity
Symbols
Reflection
Senses
Behaviour
Words
Vivid Activity
Signs
Communicativeness
Artefact
User
The interactive object in this figure is ph
the artefact. In most HCI research the
but it only present in the use activity rep
application. This is not the case with 'w


Learning Activity Theory [AT]
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Sensitivity
Contracts
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Shape
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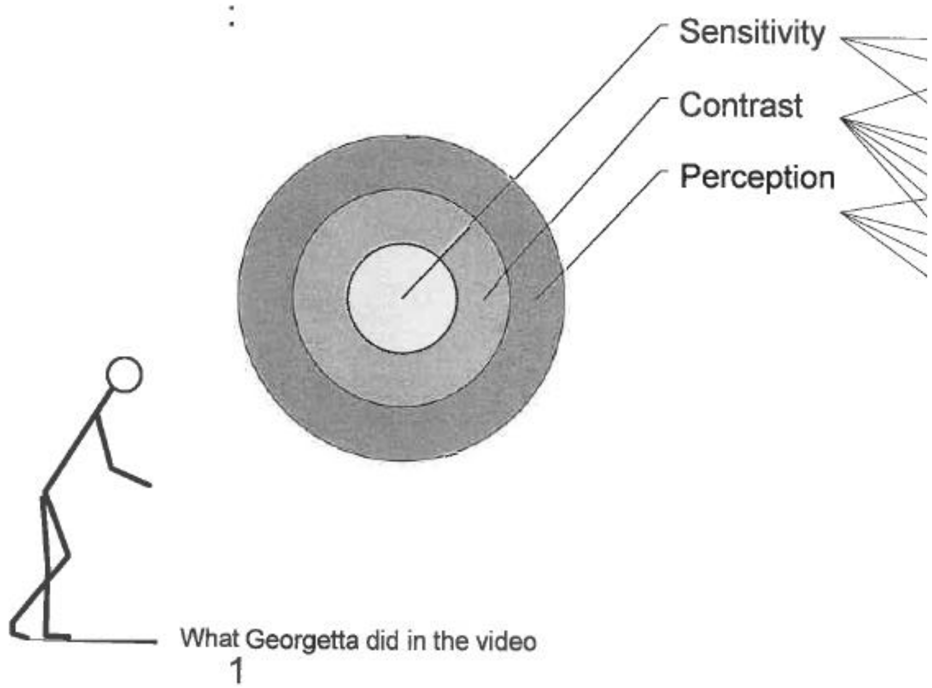
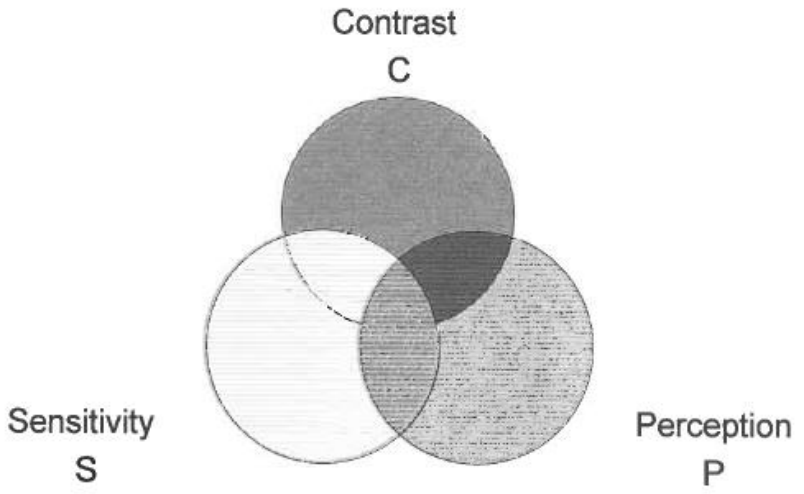
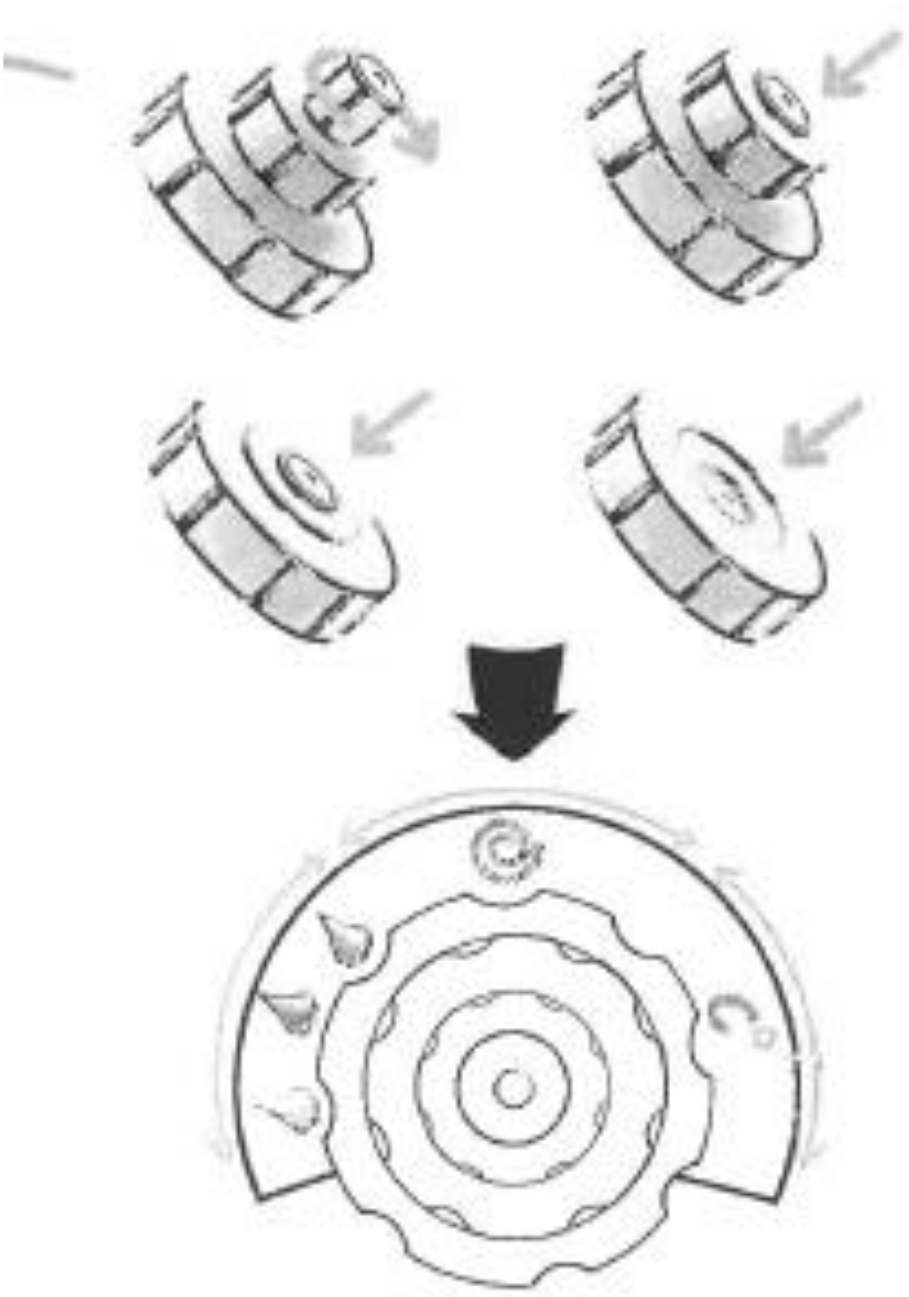
Learning Activity Theory [AT]



When the process broke down or the focus shifted she commented on issues such as:





Any Questions?

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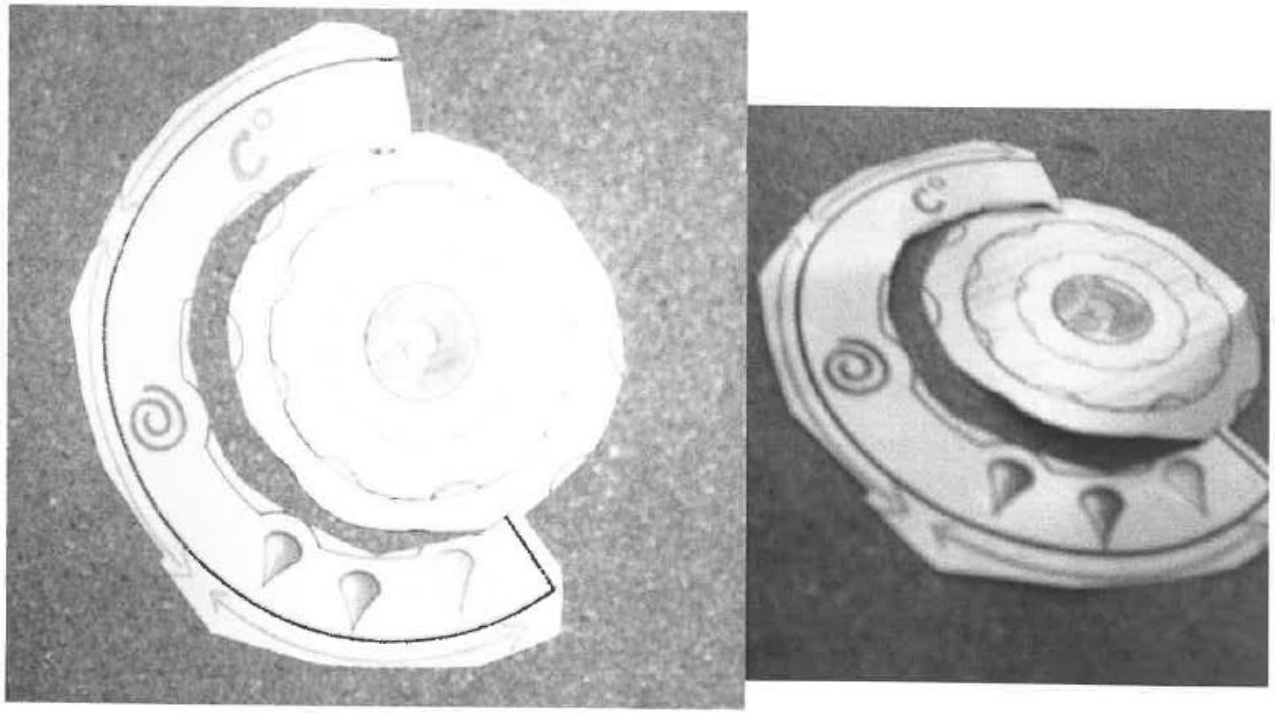
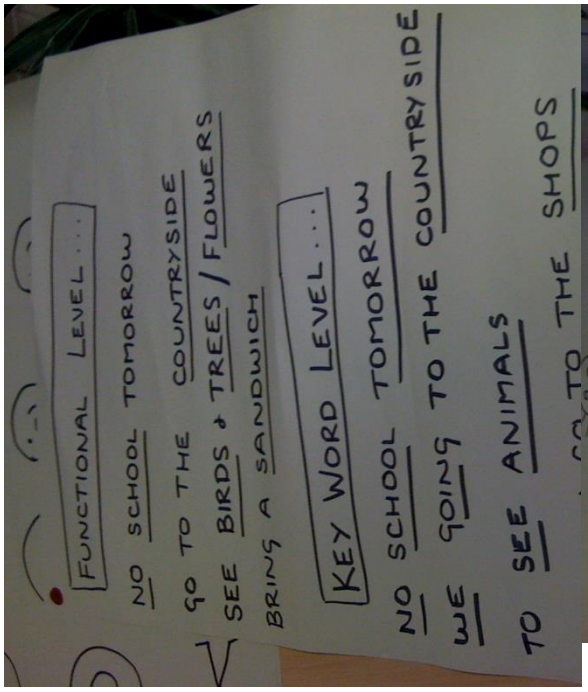
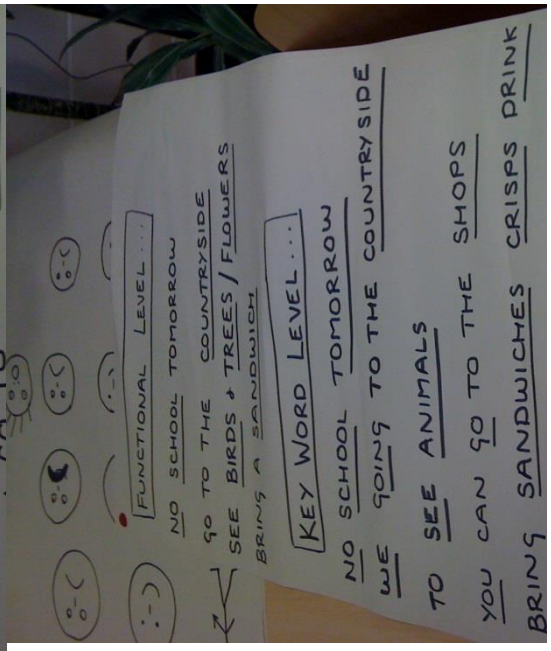
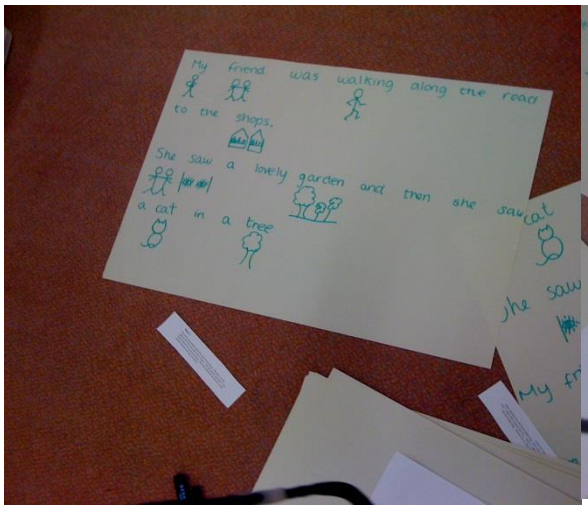
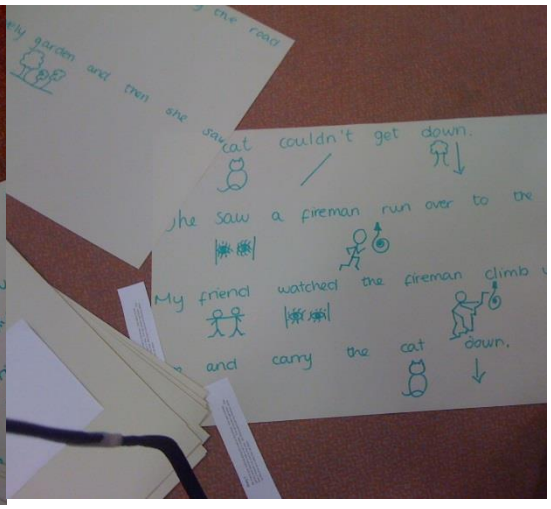
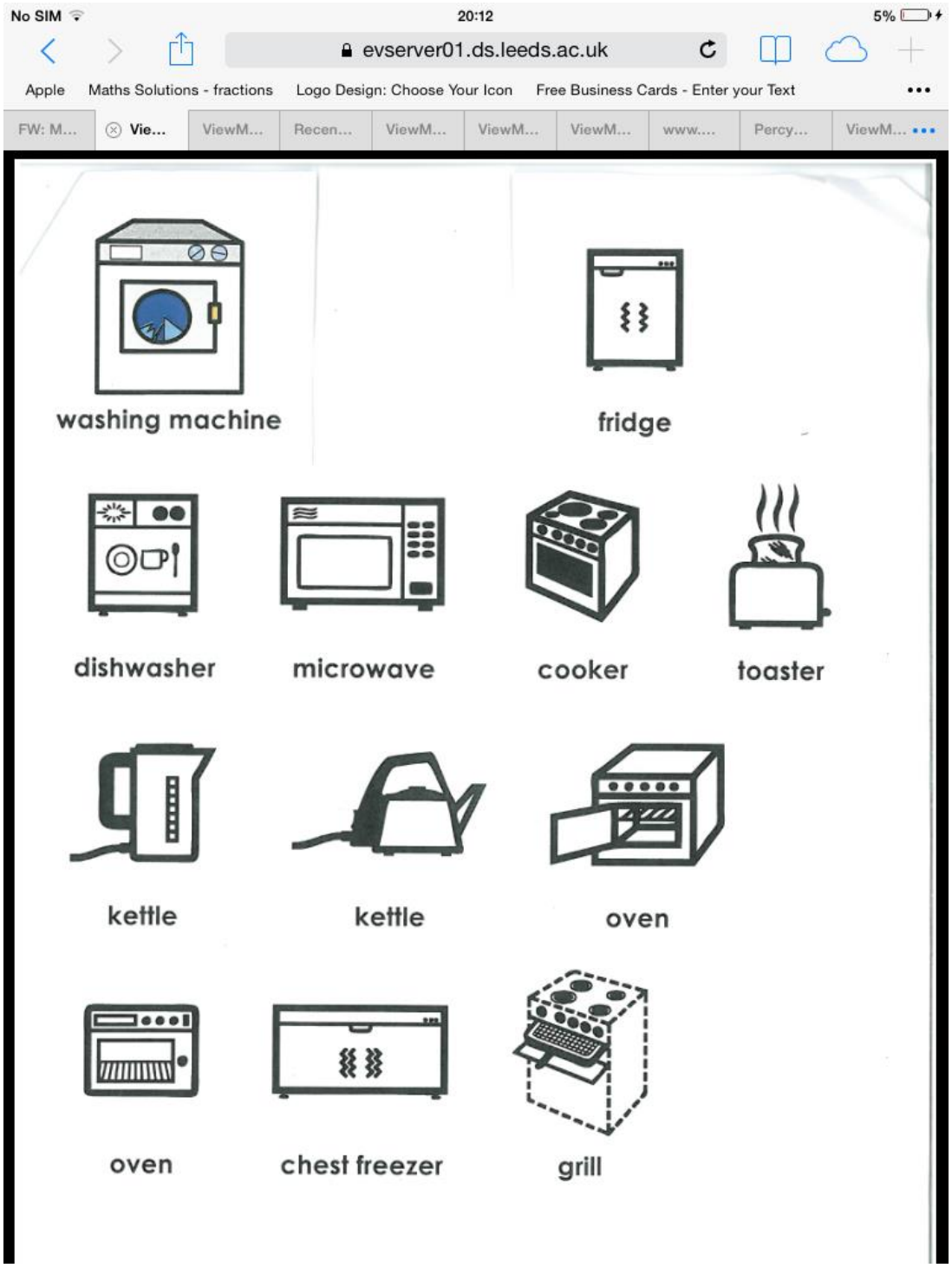



FUNCTIONAL LEVEL...
NO SCHOOL TOMORROW
GO TO THE COUNTRYSIDE
SEE BIRDS & TREES / FLOWERS
BRING A SANDWICH
KEY WORD LEVEL...
NO SCHOOL TOMORROW
WE GOING TO THE COUNTRYSIDE
TO SEE ANIMALS
TO SEE THE SHOPS


FUNCTIONAL LEVEL...
NO SCHOOL TOMORROW
GO TO THE COUNTRYSIDE
SEE BIRDS & TREES / FLOWERS
BRING A SANDWICH
KEY WORD LEVEL...
NO SCHOOL TOMORROW
WE GOING TO THE COUNTRYSIDE
TO SEE ANIMALS
YOU CAN GO TO THE SHOPS
BRING SANDWICHES CRISPS DRINK


My friend was walking along the road
to the shops.
She saw a lovely garden and then she saw
a cat in a tree


cat couldn't get down.
She saw a fireman run over to the
My friend watched the fireman climb
and carry the cat
down.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ViewM...
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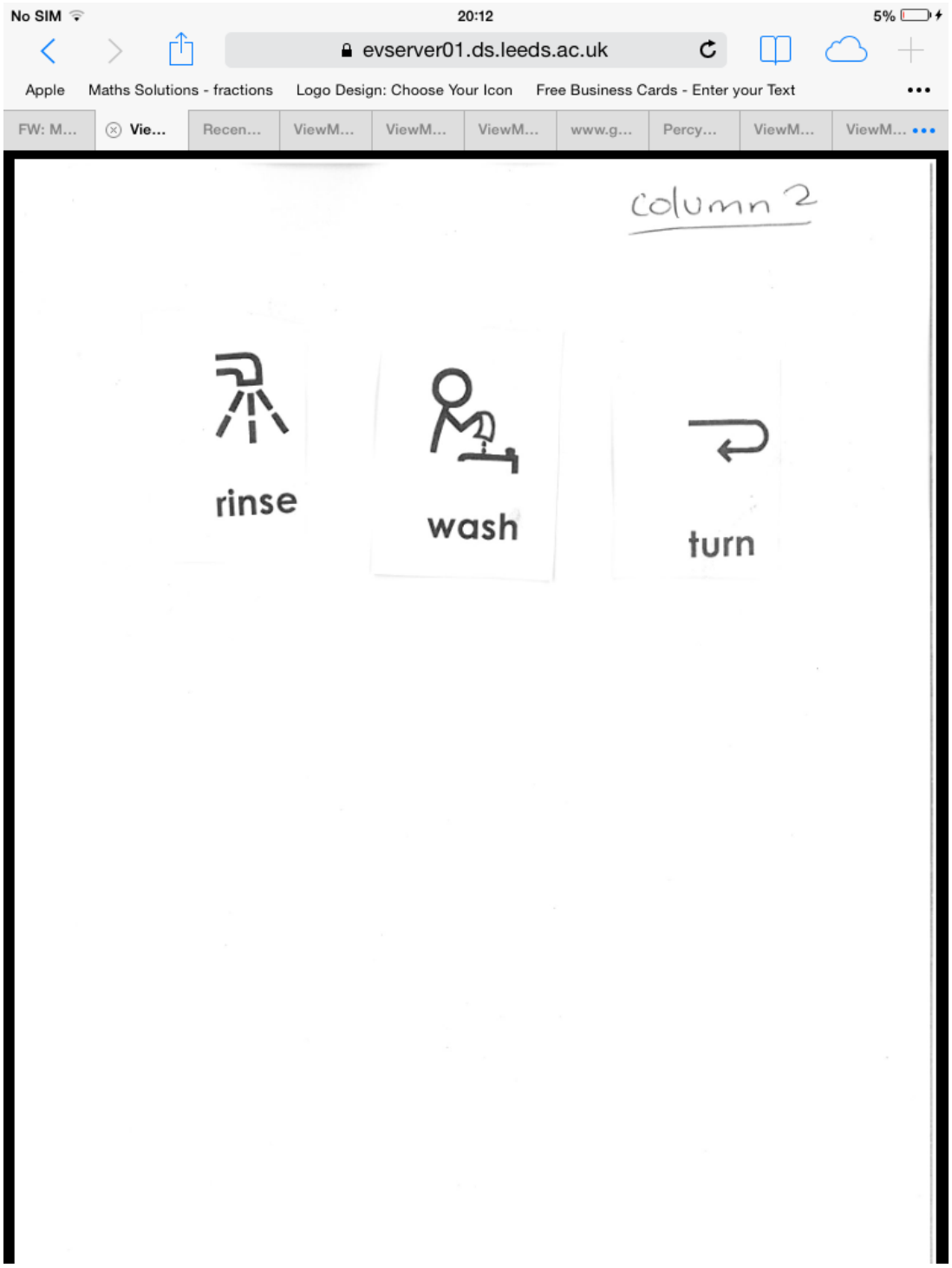
fridge
dishwasher
microwave
cooker
toaster
kettle
kettle
oven
oven
chest freezer
grill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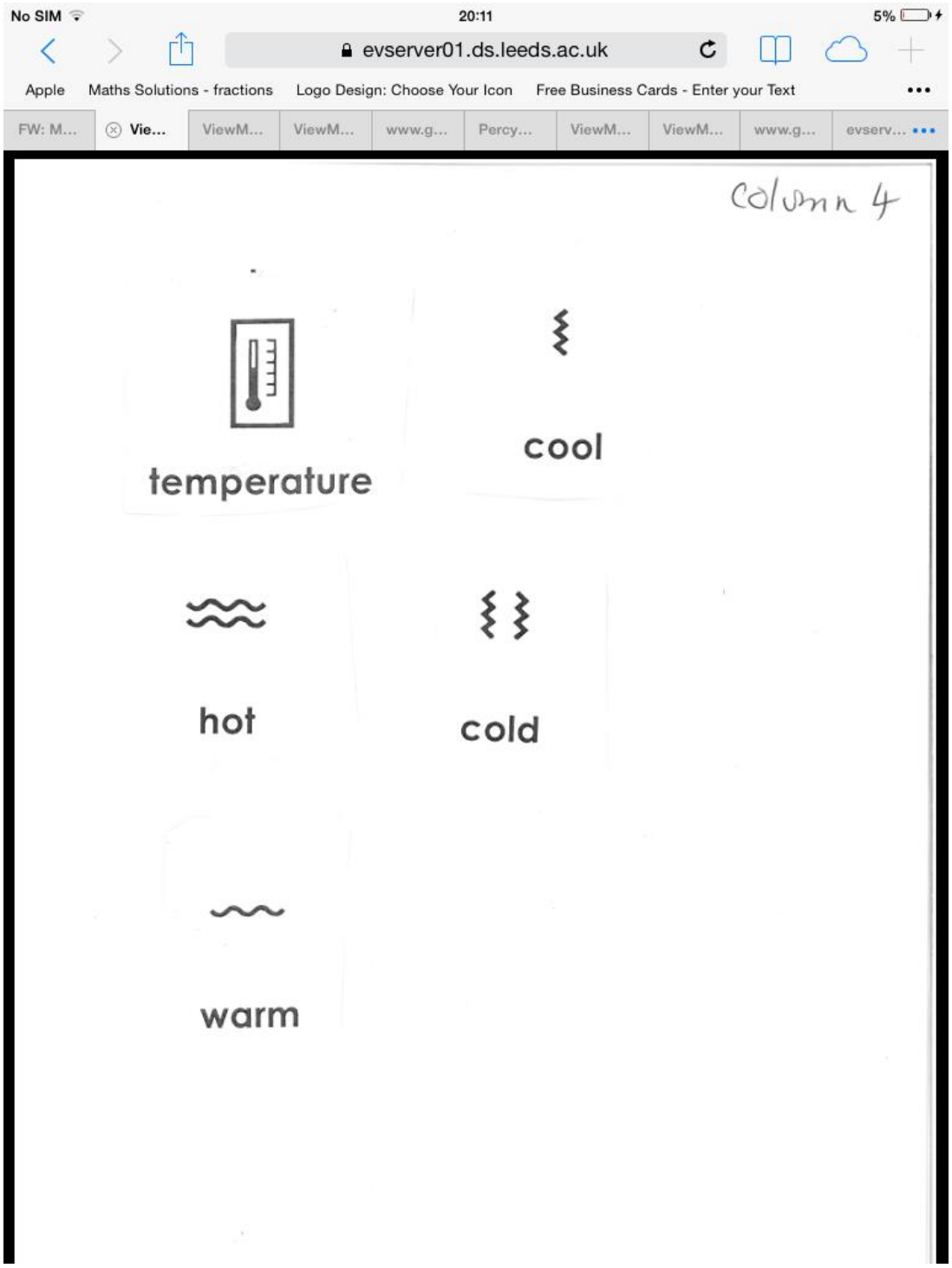
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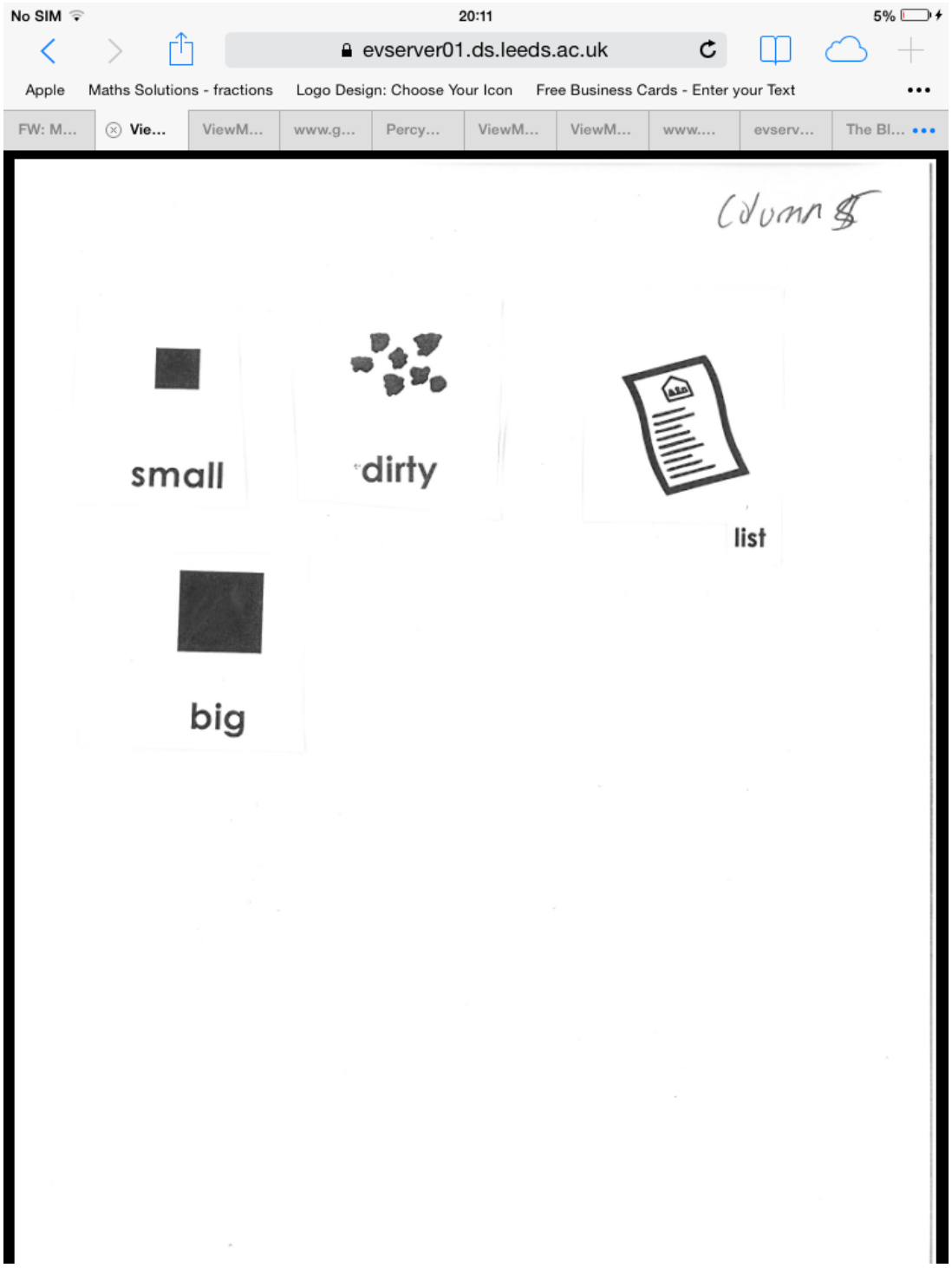
hot
cold
warm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Free Business Cards - Enter your Text
Column 5
small
dirty
list
big


No SIM
20:10
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evserver01.ds.leeds.ac.uk
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Maths Solutions - fractions
Logo Design: Choose Your Icon
Free Business Cards - Enter your Text
Column 5
STOP
stop
change
switch on
choose/option
pause
finish
change
switch off

A.1.3 Prototypes

Figure A.1.2 Development of the New Interface

A.1.4 New Operational Interface Design

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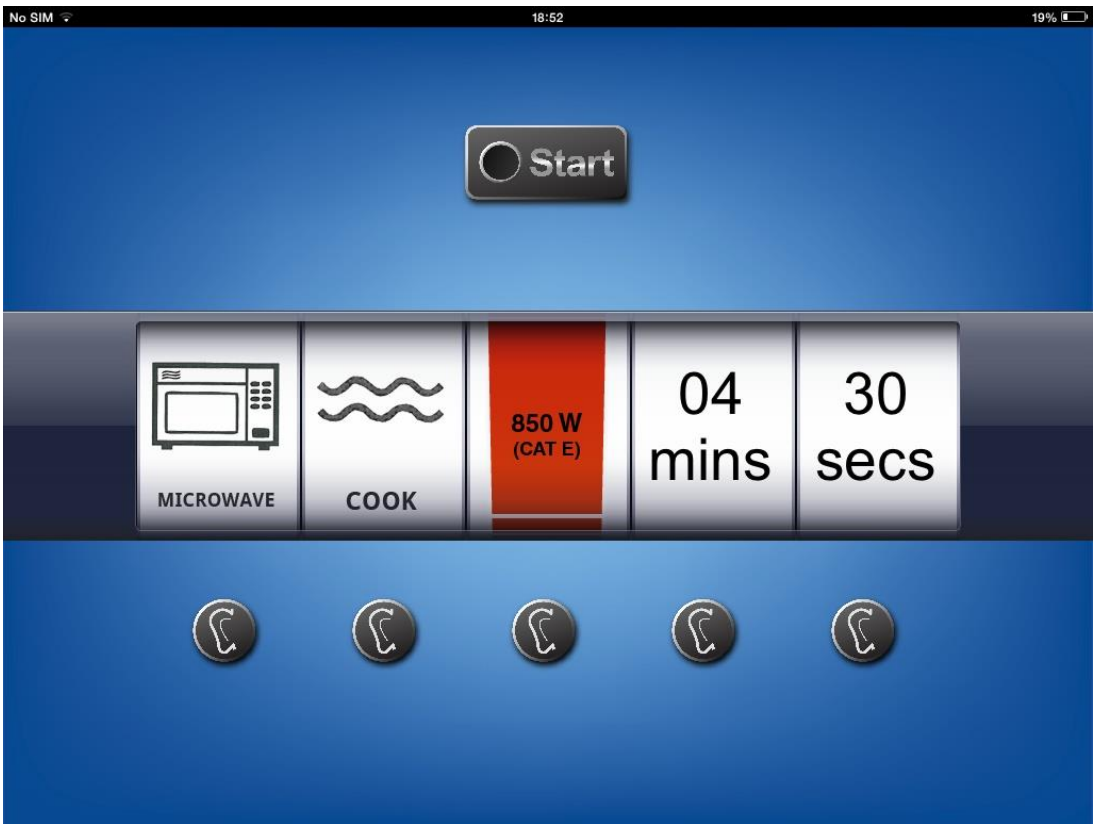

Figure A.1.3 New Operational Interface on iPad App (Reproduced from Figure 6.1)

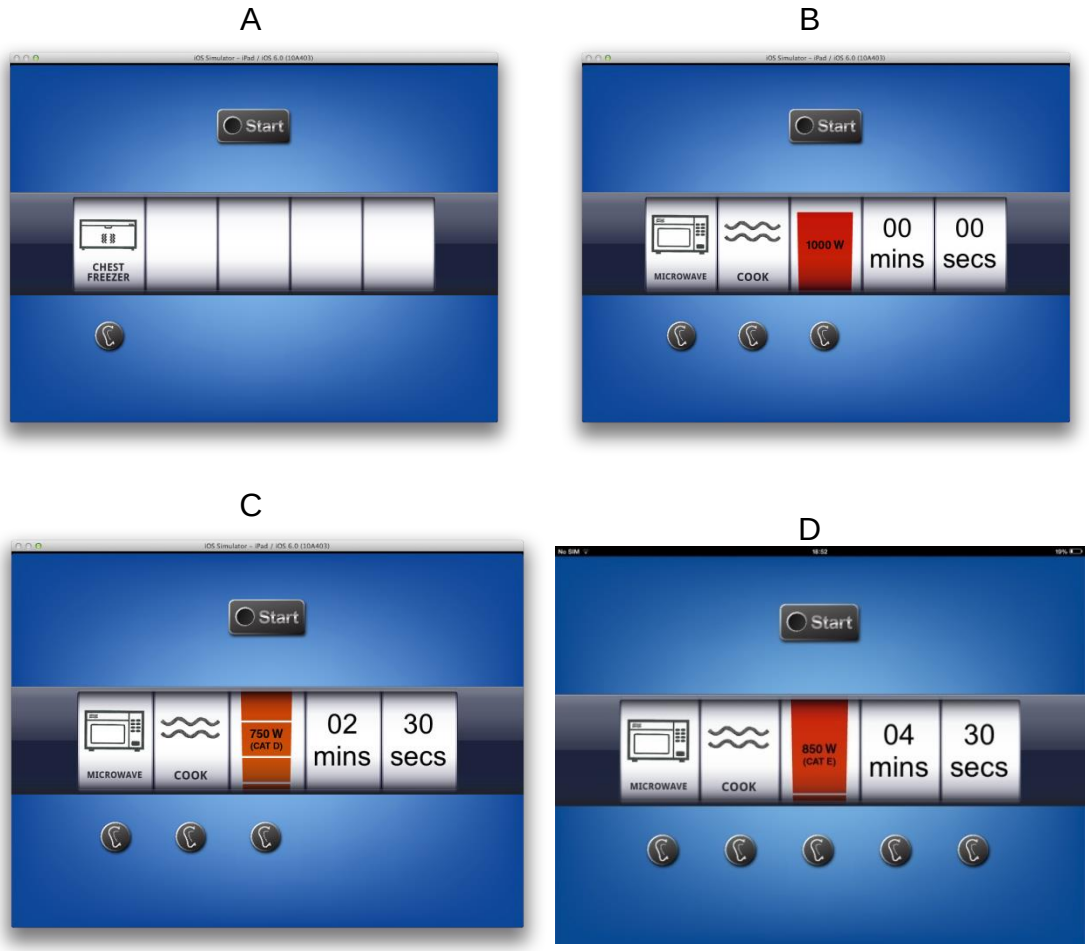

Figure A.1.4 Operational Interface Sequence for New Microwave Oven Interface

Figure A.1.5 Operational Sequence for New Washing Machine Interface

Appendix B
Research Study Ethics Approval
(Ethics reference MEEC 10-028)

Performance, Governance and Operations
Research & Innovation Service
Charles Thackrah Building
Leeds LS2 9LJ
Tel: 0113 34 34873
Email: j.m.blaikie@leeds.ac.uk

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Lisa-Dionne Morris
School of Mechanical Engineering
University of Leeds
Leeds, LS2 9JT
MEEC Faculty Research Ethics Committee
University of Leeds
15 June 2017

Dear Lisa-Dionne

Research title The Design of Operational Interfaces for Older Adults

Ethics reference MEEC 10-028

I am pleased to inform you that the amendment to the application listed above has been reviewed by the Chair of the MaPS and Engineering joint Faculty Research Ethics Committee (MEEC FREC) and I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	*Version*	*Date*
MEEC 10-028 Amendment_form.doc	1	27/06/12

Please notify the committee if you intend to make any further amendments to the research as submitted at date of this approval. This includes recruitment methodology. All changes must be ethically approved prior to implementation.

Please note: You are expected to keep a record of all your approved documentation, as well as documents, such as sample consent forms, and other documents relating to the study. This should be kept in your study file, which should be readily available for audit purposes. There is a checklist listing examples of documents to be kept which is available at

http://researchsupport.leeds.ac.uk/index.php/academic_staff/good_practice/other_information_nhs_sites in the '*Other useful documentation'* section.

Yours sincerely

Jennifer Blaikie

Senior Research Ethics Administrator, Research & Innovation Service

On behalf of Professor Gary Williamson, Chair, **MEEC FREC**

Appendix C
Methods use to Recruit Participants (Email to Older Adults' Lunch time Group in Hull, Examples of the Advertising Poster Information about the Study & Consent Form

Sent: 11 December 2012 16:57

To: Lisa-Dionne Morris

Subject: The Design of Operational Interfaces for Older Adults

Operational Breakdowns and Shift-Focus
Facilitating Meaningful Interaction between Older Consumers, Information Appliances and Systems

Researchers: Professor Alison McKay, Professor Thomas Cassidy and Lisa-Dionne Morris at Leeds University.

Information Sheet

Dear Sheila.

At Leeds University, within the School of Mechanical Engineering, we are working on a design and systems operation project to find out older adult's needs and aspirations for independent living in the digital age to develop guidelines for designers and design engineers working in areas of information appliances and system design in the future.

We would be delighted if the carers group and members could take part in the study. We are writing with a request for permission to talk and observe male and female members aged 65-75, requesting their involvement in one group study on Tuesday, 8th January 2013.

The event will take place during the day, preferably lunch time, in Hull (location to be confirmed). It will involve the researcher observing individuals operating/using the displays and controls on a domestic microwave oven and an iPad application. We will seek the permission of each of the participants separately and will not speak to them unless they agree to take part in the study.

Ms Lisa-Dionne Morris BA, MA (RCA)/PhD Researcher will give a 30 minute talk on Designing for an Aging Population, Technology and Ageing which will be followed by the observed tasks. The tasks will be videotaped for further reference and for the purpose of reporting. Participants will be free to communicate their ideas through informal conversation and a questionnaire. Participants will be able to ask the researchers to stop the taping at any point and they will do so accordingly. No participant will be named at any point in the writing up of the research and the views of all participants will be treated confidentially.

The activity will take place during working hours and on identified premises at a suitable time determined by group members and the researcher. Each session will be led by a professional and appropriately trained researcher namely Ms Lisa-Dionne Morris MA

(RCA)/PhD Researcher who is CRB checked and cleared. Ms Lisa-Dionne Morris will also be witnessed by or within hearing distance of other participants.

All participants involved in the study will be given lunch. I have included a list of meal options for members to pre-select their M&S meal for the event, please return this list to Lisa-Dionne Morris by 15th December 2012. The times of the study will be confirmed. We have attached a word document and an exemplar of a PowerPoint slide or advert to be used to promote the event.

Researcher contact information:

Ms. Lisa-Dionne Morris

Senior Teaching Fellow

Institute of Engineering Systems & Design

School of Mechanical Engineering

University of Leeds

Leeds

LS2 9JT

Tel. 0113 343 6665
Fax. 0113 343 2150
Email. l.d.morris@leeds.ac.uk

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Are you aged 65-75?
Do you find the displays and controls on domestic appliances confusing?

Focus group and research
at NNR to support research into
AGEING POPULATIONS

7th January noon to 2.30pm (TBC)
14th January noon to 2.30pm (TBC)

Lunch will be provided for all participants
Please take a leaflet or see Lisa-Dionne Morris for more details or email l.d.morris@leeds.ac.uk

Research project title

The Design of Operational Interfaces for Older Adults

Invitation

You are being invited to take part in a research project. Before you decide to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information sheet carefully then discuss it with others if you wish. Ask or contact the named researcher if there is anything that is not clear or if you would like more information about research. Take time to decide whether or not you wish to take part. Thank you for reading this.

Project's purpose

Usability studies relating to commercial domestic consumer appliances, known as domestic information appliances, identify the poor design of displays and controls as a major cause of user dissatisfaction. Many researchers argue that dissatisfaction is often the result of multiple errors caused by the complex composition of visual instructions and directions in addition to displays and controls.

Aims

This research aims to understand the reasons for interruptions and disruptions to work flow which is experienced by older adults through a understanding of the design of the operation operational interface on commercial domestic consumer appliances.

The study

The participants will partake in the following way:

Conduct a series of task activities with a variety of working commercial domestic consumer appliances (domestic information appliances). Commercial domestic consumer appliances might include the following appliances: a microwave; washing machine; cooker; toaster; dishwasher and fridge. The main research study will observe participants using the Daewoo KOC9Q3T Combination Microwave, 28 L, 900 W – Black. Complete a survey about issues and problems when operating the microwave oven.

Attend a focus group event with other participants.

Have the actions video recorded.

All of the tasks carried out during the research study will be low risk. The appliance has been PAT Tested to ensure its electrical safety. The researcher will be present at all times. There are no lifestyle restrictions as a result of participating. Your task will take a total of 30 minutes. Your task will be videotaped. The research will be conducted on the Leeds University premises and off campus. Travel expenses will be reimbursed (if applicable).

Recorded media

A videotape recording of the task will be used only for data collection and analysis. No other use will be made of the videotape recordings without written permission being sought, and no one outside the project will be allowed access to the original videotape recordings.

Survey data

Survey data will be used only for data collection and analysis. No other use will be made of the survey data without written permission being sought, and no one outside the project will be allowed access to the original data.

Participants

You have been chosen based on the following criteria:

age (65-75) male and female

You are one of nine other participants carrying out this research.

Voluntary participation

It is up to you to decide whether or not to partake. If you do decide to partake you will be given an information sheet to keep then given a consent form to sign. Participants can withdraw at any time without it affecting any benefits they are entitled to in any way. Participants do not have to give a reason for their withdrawal.

Disadvantages and risks of partaking

There are no reasonable or foreseeable discomforts, disadvantages and risks associated with you taking part in the research.

Benefits of partaking

Whilst there are no immediate benefits for those participates involved in the project, it is hoped your involvement will help you understand reasons why you might have usability issues with displays and controls on domestic information appliances.

Confidentiality

All data collected will be kept strictly confidential. You will not be able to be identified in any reports or publication which originates from the research data.

Data protection

All data will be stored on a secure password-protected server. There will be appropriate backups and firewall protection to secure the data. Data will be used for research purposes only. It will be held for the time of research, until the end of the PhD study in 2015. Participants will be identified exclusively by a given ID code.

Information needed

The following information will be sought from all participants:

Age

Gender

Any age related disabilities

Information relating to the use of a number of commercial domestic consumer appliances

The collection of this information is relevant to achieve the research study aims and objectives.

The research study results

The results of the research study are likely to be published from 2013 onwards. You will be able to obtain a copy of all published results from 2013 onwards. Participants will not be identified in reports and/or publications in anyway. If the data collected during the course of this research study are to be used for any additional or subsequent research study permission for its use will be explicitly sought.

Organisation funding the research

Leeds University is sponsoring the research.

Further information

If you have any questions please contact Ms. Lisa-Dionne Morris on 0113 343 6665 alternatively email by l.d.morris@leeds.ac.uk. All participants will be given a copy of the information sheet and if appropriate, their signed consent form to keep. I would like to thank all participants in advance for agreeing to partake in the research.

Title of Research Project: Design Operational Interface for Older Adults

Name of Researcher: Ms. Lisa-Dionne Morris

Tick the box if you agree with the statement.

1 I confirm that I have read and understood the information sheet and I have had the opportunity to ask questions about the project.

2 I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason why I want to withdraw. I understand that by withdrawing there will be no negative consequences. In addition, should I not wish to answer any particular survey question(s) I am free to decline to answer. I understand that if I have any questions I will contact Ms. Lisa-Dionne Morris on 0113 343 6665 alternatively email by l.d.morris@leeds.ac.uk to seek advice or confirmation.

3 I understand that my response(s) will be kept strictly confidential. I give permission for supervisors of this researcher study to have access to my anonymised response(s). I understand that my name will not be linked to the research data and I will not be identified or identifiable in reports or papers.

4 I agree for the data collected from me to be used in publications or research.

5 I agree to partake in the stated research project and I will inform the principal investigator should my wishes change.

_____	_____	_____
Name of participant (or legal representative)	Date	Signature
_____	_____	_____
Name of person taking consent (if different from lead researcher)	Date	Signature

To be signed and dated in presence of the participant

_____	_____	_____
Lead researcher	Date	Signature

To be signed and dated in presence of the participant

Copies:

Once this has been signed by all parties participants will receive a copy of the signed and dated information sheet and consent form by mail. A copy of the signed and dated consent form will be kept with the project's main documents which will be kept in a secure location.

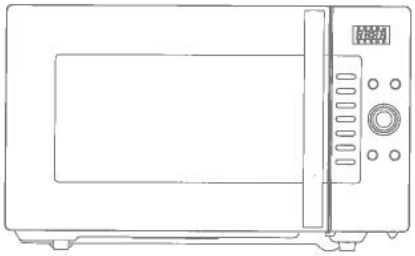
Appendix D
Instructional Materials used in the Research Study

The instructions for using the new operational interface for the microwave oven.

1. Select and operate the first reel (reels can only be operated in sequential series)
2. Choose the image of the appliance you want to operate
3. Select and operate the second reel
4. Choose an image, symbol or word related to the task
5. Repeat step two using the third, fourth and fifth reel
6. Press start when you have completed your desired cook cycle.

On completion of the fifth reel, the sequential series are spoken in words to confirm the task.

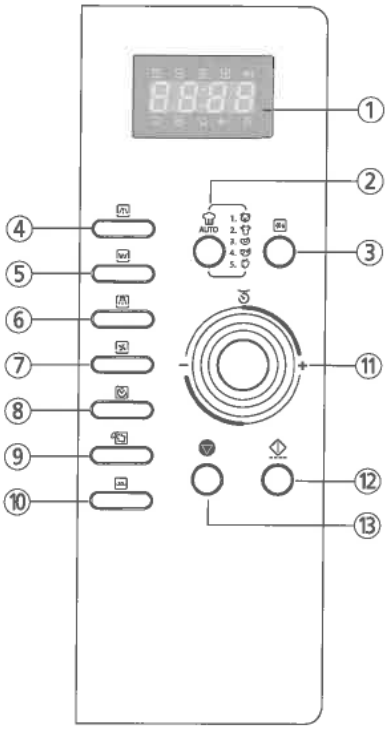
DAEWOO ELECTRONICS



MODEL NO.
KOC-9Q3T / KOC-9Q3TC

MICROWAVE CONVECTION/GRILL OVEN

»Control panel



KOC9Q3T

↘ DISPLAY WINDOW

① **Display :** Cooking time, power level, program indicators and present time are displayed.

MW ( ): When blinking, the oven is operating in MICROWAVE COOK mode.

Grill ( ): When blinking, the oven is operating in GRILL mode.

Combi ( ): When blinking, the oven is operating in COMBI mode.

Convection ( ): When blinking, the oven is operating in CONVECTION mode.

Defrost ( ): When blinking, the oven is operating in DEFROST mode.

Auto-cook ( ): When blinking, the oven is operating in AUTO COOK mode.

Warm ( ): When blinking, the oven is operating in WARM mode.

Steam Cleaning ( ): When blinking, the oven is operating in steam cleaning mode.

gram ( ): When blinking, the oven is operating in weight input mode.

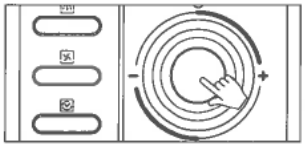
↘ BUTTONS

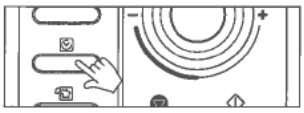
② Auto cook : Used to cook or reheat.
③ Defrost : Used to defrost foods.
④ MW : Used to set power level of the microwave.
⑤ Grill : Used to select grill mode.
⑥ Combi : Used to select combi mode.
⑦ Convection : Used to select convection mode and selected temp.
⑧ Clock : Used to set clock.
⑨ STEAM CLEANING : Used to clean the inside of the oven
⑩ Warm : Used to keep the food warm.
⑪ Dial knob : Used to set time, weight and quantity.
⑫ START/SPEEDY COOK : Used to start a program or a speedy start(each press adds 30 seconds of microwave cooking time).
⑬ STOP/CLEAR : Used to stop the oven operation or to delete the cooking data.

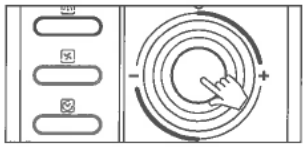
BEFORE OPERATION

»SETTING THE CLOCK

When your oven is plugged in, the display will show " :0" and a tone will sound. If the AC power goes off and comes back on, the display will show ":0".
Your oven has a multiple(12hr/24hr) clock system. To set the clock, follow the procedure below.







Example : To set 5:30 AM in a 24hr clock system.

1. Press **Clock** button once.
   The display will show " 12H ". This is a 12 hour clock system.
2. Press **Clock** button once more, the display shows "24H".
   This is a 24hour clock system. If you want 12hour clock system, omit this step.
3. Turn the **dial knob** to set the hour number "**5:**".
   The hour digit starts blinking, the colon will light.
4. Press **Clock** button. "**5:00**" shows in display.
   The minute digit starts blinking, the colon and hour number will light.
5. Turn the **dial knob** until "**5:30**" shows in the display window.
6. Press **Clock** button. The colon starts blinking.
   If you selected the 12hour clock system, this digital clock allows you to set the time from **1:00** to **12:59**.
   If you selected the 24hour clock system, this digital clock allows you to set the time from **0:00** to **23:59**.

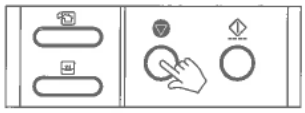
NOTE

»CHILD LOCK AND POWER SAVE MODE

Child lock : The Child Lock function helps to prevent accidents from children operating the oven without being monitored by the parents.
Power save mode : This function is used for saving energy.

To set child lock

1. Press the **STOP/CLEAR** button.
   ": 0" or clock appears in the display.
2. Press and hold the **STOP/CLEAR** button for 3 seconds.
   A beep sounds and the display shows " Loc " for 3 seconds.
   Now the oven cannot be operated.
3. To cancel child lock simply repeat procedure 2.
   The oven will beep.
   The oven is again available for normal use.



To set power save mode

1. Press the **STOP/CLEAR** button.
   ": 0" or clock appears in the display.
2. Press and then hold the **Clock** button for 3 seconds.
   The display will turn off and a beep sounds.
   To operate the oven in power save mode, press any key or turn the knob.
   Then **":0"** or clock will be shown and the operation of all function keys will be the same as in the normal mode.
   But if there is no operation within 10 seconds in clear mode or while manipulating the key, all the contents of display will disappear.
3. To cancel the power save mode, simply repeat the setting procedure.
   The power save mode will be canceled and a beep sounds.
   The oven is again available for normal use.

OPERATION

TIPS

Please read this OPERATION section for the proper safety information and the operating instructions before using the oven.
Prior to setting the controls, place one cup of water in the oven, in a heat-proof glass measuring cup, for testing purposes.
The oven could be damaged if you operate the oven in microwave mode without anything in the cavity.

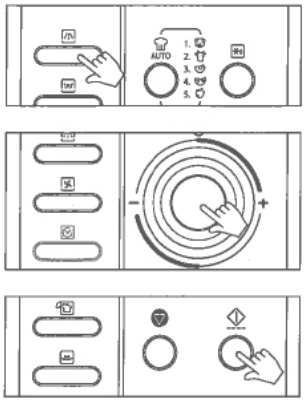
NOTE

When the cooking time has elapsed the oven beeps three times and "End" appears on the display. The glass turntable stops and the oven-light turns off. The oven will continue to beep every one-minute until either the STOP/CLEAR button is pressed or the door is opened. Opening the door while cook is in progress will cause the oven to stop and any displayed countdown will pause. If the START/SPEEDY COOK button is pressed, the countdown will resume. If the STOP/CLEAR button is pressed, the cook will cancel. The oven can display the set cooking time in 10 second steps (up to 5 minutes cooking time), in 30 second steps (up to 10 minutes cooking time), and in 1 minute steps (up to 60 minutes cooking time).
When the door is opened after cooking, the cooling fan may start to operate for 5 minutes to cool down the inside of oven. (Display shows "cool" and " :0 or clock")
Also note that when the Cooling mode operates, lamp, tray, and fan runs at the same time and "cool" shows on the display.

OPERATION

»MICROWAVE COOKING

This microwave cooking method allows you to cook food for a desired time. In addition to the maximum power level(**100%**), you can select different microwave power from 9 other levels, **10%** to **90%** for the foods that require slower cooking.
If you have used the appliance for grilling, convection or combination cooking, let the oven cool down before using again.
Never switch the microwave oven on when it is empty.



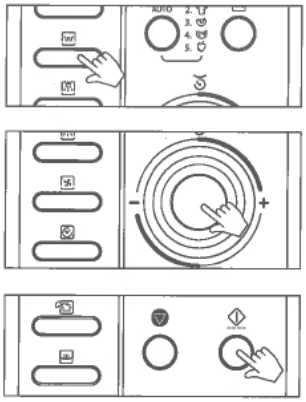
1. Press the **MW** button once. **MW** indicator (MW) lights.
   "**P-HI**"(POWER HIGH) shows in display.
2. Select the appropriate power level by pressing the **MW** button again until the corresponding percentage is displayed. Refer to the power level table below for further details.
3. Turn the **dial knob** to set the cooking time.
   For a cooking time of 5 minutes 30 seconds, turn the **dial knob** to set 5:30.
   (up to 60 minutes can be set)
   "**5:30**" shows in display.
4. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

NOTE

The oven will automatically work on 100% microwave power if a cooking time is entered without the power level previously being selected.
You can check the power level while cooking is in progress by pressing the MW button.

▶ **Power level table**

Power level	percentage	Output	Power level	percentage	Output
P-HI	100%	900W	P-50	50%	450W
P-90	90%	810W	P-40	40%	360W
P-80	80%	720W	P-30	30%	270W
P-70	70%	630W	P-20	20%	180W
P-60	60%	540W	P-10	10%	90W
			P-00	0%	0W



1. Press the **Grill** button once. The **GRILL** indicator ( ) lights.

2. Turn the **dial knob** to set the grilling time.
   For a grilling time of 11 minutes, turn the **dial knob** to set 11:00.
   (up to 60 minutes can be set)
   "11:00" shows in display.

3. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

NOTE

The heating element is located on the top surface of the oven.

NOTE

When using the grill heater for the first time, smoke and odour will be given off. To avoid this happening when food is being cooked, turn the heater on with a microwave safe bowl containing 200cc of water in the oven for 10 minutes and the odour will disappear from then on.
Grill food by placing it directly on the rack, in a flat dish or on a heat resistant plate on the rack.

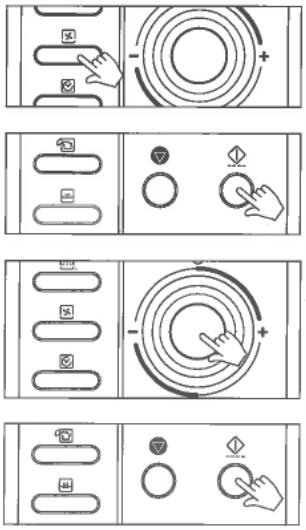
WARNING :
The temperature inside the oven and window is very high.
Do not touch the oven window and metallic interior of the oven when taking food in and out.
Use thick oven gloves while handling food or accessories.

Suggested use	Cookware
This methods is ideal for toasting bread or muffins. Remember the oven will be hot. Place all food on low/high rack.	Use oven-proof cookware. As there is no microwave energy being used you can place metal tins directly onto the metal racks with no danger of arcing.

OPERATION

»CONVECTION COOKING(with pre-heat)

For convection cooking, it is recommended to preheat the oven to the appropriate temperature (except for the 40C that displays only) before placing food in the oven.
The maximum preheating time is 30 minutes.
If cooking is not started immediately after preheating, the convection indicator will continue to flash and the preheated oven temperature will be displayed. It will be maintained for 15 minutes; then switch off automatically.



1. Press the **Convection** button once. The **CONVECTION** indicator ( ) lights.
   "180C" shows in display.

2. Select the convection cooking temperature by pressing the **Convection** button again until the corresponding temperature is displayed.

TEMPERATURE SEQUENCE
180C → 190C → 200C → 210C → 220C → 40C → 100C → 110C → 120C → 130C → 140C → 150C → 160C → 170C

3. Press **START/SPEEDY COOK** button. The **CONVECTION** indicator ( ) blinks.
   The temperature of preheating and **"PrE-"** blink alternatively in the display.
   The oven will now preheat. When the oven reaches the preheated temperature the oven will beep and the preheated oven temperature will appear in the display.
   Then open the door and place your food in the oven.
   The oven temperature now shows in the display.

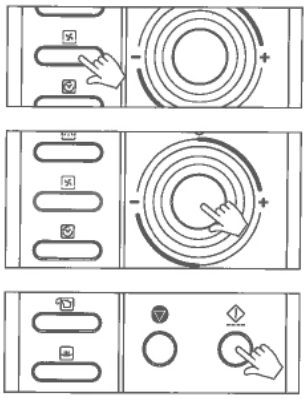
4. Turn the **dial knob** to set the cooking time.
   For a cooking time of 11 minutes, turn the **dial knob** to set 11:00.
   (up to 60 minutes can be set)
   "11:00" shows in display.

5. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

OPERATION

»CONVECTION COOKING(traditional cooking)

The convection mode enables you to cook food in the same way as in a traditional oven. Microwaves are not used.
Always use oven gloves when touching the utensils in the oven, as they will be very hot.



1. Press the **Convection** button once. The **CONVECTION** indicator ( ) lights.
   "180C" shows in display.

2. Select the convection cooking temperature by pressing the **Convection** button again until the corresponding temperature is displayed.

TEMPERATURE SEQUENCE
180C → 190C → 200C → 210C → 220C → 40C → 100C → 110C → 120C → 130C → 140C → 150C → 160C → 170C

3. Turn the **dial knob** to set the cooking time.
   For a cooking time of 11 minutes, turn the **dial knob** to set 11:00.
   (up to 60 minutes can be set)
   "11:00" shows in display.

4. Press **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

NOTE

You can check the setting temperature while cooking is in progress by pressing the Convection button.

Fermentation
• 40C of convection cooking temperature is adequate for fermenting bread-like foods. • High temperatures in the inside of oven may reduce the quality of fermentation. Cool it down to the room temperature before use.

Suggested use	Cookware
This function is ideal for cooking meringues, cookies, biscuits, scones, bread, puddings, large fruit cakes and all pastries. Remember the oven will be hot. Place all food on the metal rack.	Use oven-proof cookware. As there is no microwave energy being used you can place metal tins directly onto the metal rack with no danger of arcing.

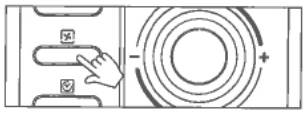
OPERATION

»COMBINATION COOKING

This function allows you to combine convection operation with microwave to produce traditional baked or roasted results in less time.
Always use microwave-safe and oven-proof cookware. Glass or ceramic dishes are ideal as they allow the microwaves to penetrate the food evenly.
Always use oven gloves when touching the utensils in the oven, as they will be very hot.

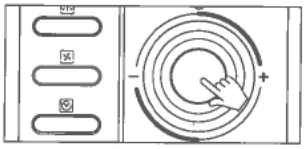
1. Press the **Combi** button once.
The **COMBI** indicator ( ) light and **"C-0"** will show in the display.

Display	MW Power
C - 0	30%

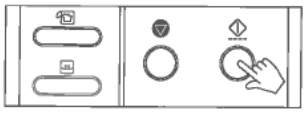


2. Press **Convection** button once.
"180˚C" shows in display.
Select the convection cooking temperature by pressing the Convection button again until the corresponding temperature is displayed.

TEMPERATURE SEQUENCE
180C → 190C → 200C → 210C → 220C → 40C → 100C → 110C → 120C → 130C → 140C → 150C → 160C → 170C



3. Turn the **dial knob** to set the cooking time.
For a cooking time of 11 minutes, turn the **dial knob** to set 11:00.
(up to 60 minutes can be set)
"11:00" shows in display.



4. Press the **START/SPEEDY COOK** button.
The oven light comes on and the turntable starts rotating.
Cooking starts and the time in the display will count down.

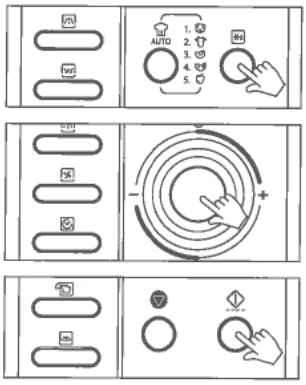
NOTE

*You can check the cooking temperature while cooking is in progress by pressing the **Convection** button.*
You can check the power level while cooking is in progress by pressing the Combi button.

OPERATION

↘WEIGHT DEFROST MODE

Weight Defrost automatically sets the defrosting times and power levels to give even defrosting results for frozen food.
During the defrosting process the oven will beep to remind you to check the food. When the oven beeps, open the door, turn the frozen food over and close the door, and press the START/SPEEDY COOK button again.



1. Press the **Defrost** button once. The **Defrost** indicator (✻) lights and **"0"** is displayed. The (ಠ) indicator blinks.
   This is a weight defrost mode.

2. Turn the **dial knob** to set the weight.
   Weight can be set up from 200g to 3000g.
   The weight will change in 50g increments or decrements.
   For a defrosting weight of 1000 grams, turn the **dial knob** to set 1000.
   "1000" shows in display.

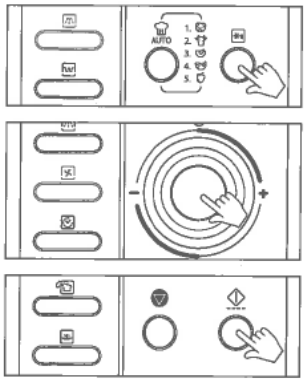
3. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating. The (ಠ) indicator goes off.
   Cooking starts and the time in the display will count down.

NOTE

When Weight-Defrosting begins, the defrosting time is automatically determined by the weight entered.

↘TIME DEFROST MODE

During the defrosting process the oven will beep to remind you to check the food.
When the oven beeps, open the door, turn the frozen food over and close the door, and press the **START/SPEEDY COOK** button again.



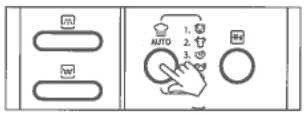
1. Press the **Defrost** button twice.
   The **Defrost** indicator (✻) lights and **": 0"** is displayed.
   This is a time defrost mode.

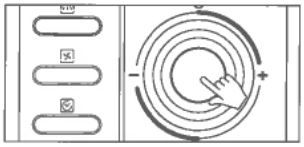
2. Turn the **dial knob** to set the defrosting time.
   For a time of 11 minutes, turn the **dial knob** to set 11:00.
   (up to 60 minutes can be set)
   "11:00" shows in display.

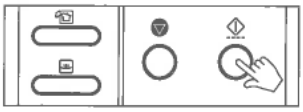
3. Press **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

This function allows you to simply and automatically cook a range of popular foods.
Always use oven gloves when touching the utensils in the oven.

Press Auto Cook key	Auto Cook Menu	Minimum Weight	Maximum Weight	Weight Step
Once	1 ROAST PORK	500 g	2000 g	100 g
Twice	2 ROAST BEEF	500 g	2000 g	100 g
3 times	3 ROAST CHICKEN	800 g	2000 g	100 g
4 times	4 BAKED FISH	300 g	900 g	100 g
5 times	5 FRESH VEGETABLE	100 g	900 g	50 g







1. Press the **Auto Cook** button once.
   The **Auto Cook** indicator ( ) lights.
   "**AC-1**" will show in the display.

2. Select the menu by pressing the **Auto Cook** button until the required menu is displayed.
   Refer to the auto cook menu chart below for further details.

3. Turn the **dial knob** to set the cooking weight.
   For a cooking weight of 1000 grams, turn the **dial knob** to set 1000.
   (up to 2000 grams can be set)
   "**1000**" and ( ) shows in display.
   Refer to the auto cook menu chart below for further details.

4. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Cooking starts and the time in the display will count down.

NOTE

You can check the current cook setting while the cooking is in progress by pressing the Auto Cook button.

▶ AUTO COOK TABLE

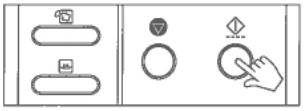
Auto Cook Menu	Start Temp.	Method	Cookware
ROAST PORK ROAST BEEF	Chilled temp.	1. Tie the joint into a neat shape. 2. Place the meat on the dish. 3. Brush with a little oil. 4. Place roasts fat-side down on the dish. 5. Cook on "AUTO COOK-ROAST PORK or ROAST BEEF". 6. Turn over when hearing the beep. 7. Remove from oven. Drain off any excess juices. 8. Stand for 10 minutes in foil before serving.	Glass Turntable + Metal rack
ROAST CHICKEN	Chilled temp.	1. Wash and dry chicken. Tie the legs loosely together with string. 2. Pierce the skin a couple of times just under the legs. 3. Brush butter mixture all over the chicken on the dish. 4. Place roasts breast-side down on the dish. 5. Cook on "AUTO COOK-ROAST CHICKEN". 6. Turn over when hearing the beep. 7. Remove from oven. Drain off any excess juices. Season with salt if required. Stand for 10 minutes in foil before serving.	Glass Turntable + Metal rack

OPERATION

Auto Cook Menu	Start Temp.	Method	Cookware
BAKED FISH	Chilled temp.	1. All types of fresh fish(except battered or breadcrumbed fish) can be cooked whether whole, fillets or steaks. 2. Place the prepared fish in a buttered dish. 3. Season with salt and pepper, sprinkle with lemon juice and dot with butter. Do not cover dish. 4. Place on dish on the metal rack on the turntable. 5. Cook on "AUTO COOK- BAKED FISH".	Micro and heat proof shallow dish. (e.g Pyrex.) Glass Turntable + Metal rack
VEGETABLE	Chilled temp.	1. Wash and trim. 2. Place prepared vegetables into a suitable sized container. 3. Sprinkle with 4-5 tbs. of water. 4. Cover with pierced cling film or a lid. 5. Place on dish on the turntable. 6. Cook on "AUTO COOK- FRESH VEGETABLES. * For best results cut vegetables into similar sized pieces.	Microproof dish. (e.g Pyrex.) Glass Turntable

»SPEEDY COOK

The Speedy Cook function allows the oven to cook immediately on microwave full power.
The Speedy Cook function has been pre-programmed to increase the cooking time in increments of 30 seconds up to the maximum time of 5 minutes.

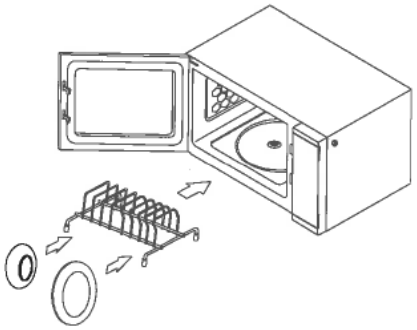


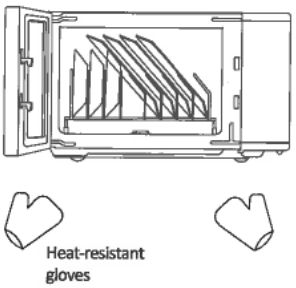
1. Press the **START/SPEEDY COOK** button.
   The oven will display as " :30", **MW** indicator (㎿) lights, and the oven starts immediately. You may increase the cooking time by keep pressing the **START/SPEEDY COOK** button.
   The oven light comes on and the turn table starts rotating and the time in the display will count down in seconds.

OPERATION

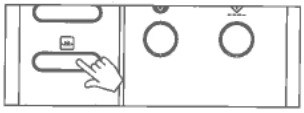
»DISH WARMER (For Premium option model only)

The DISH WARMER mode allows the oven to Warm dining dishes/plates before serving the food.
The premium option model comes with the specially designed Dish-Warm Rack used for the dish warmer mode only. Please take out the glass turntable and place the dish-warm rack at the centre of the oven cavity.
Then place dishes/plates (Size ranges from Ø150~Ø260mm) on the rack.

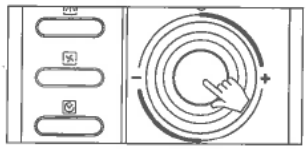




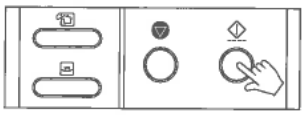
Heat-resistant gloves



1. Keep pressing the **WARM** button to select the desired temperature. (from 40°C~80°C)



2. Turn the **dial knob** to set the desired dish Warm time. (from 10 sec.~ 60 minutes)



3. Press the **START/SPEEDY COOK** button.
The oven light comes on and the turntable starts rotating.
Warming starts and the time in the display counts down.

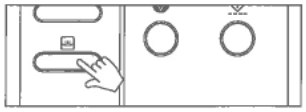
NOTE

Once the dish warmer mode ends, please do not grasp a dish or the rack with your bare hands as it may be hot. We recommend wearing heat-resistant gloves.

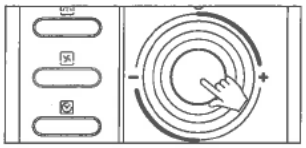
OPERATION

»WARM

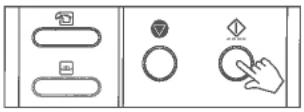
The WARM function allows the oven to Warm your food, up to the maximum time of 60 minutes.



1. Press the **WARM** button.
   (The temperature is about 60˚C.)



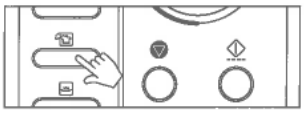
2. Turn the **dial knob** to set the cooking time.
   For a cooking time of 11 minutes, turn the **dial knob** to set 11:00.
   (up to 60 minutes can be set)
   "**11:00**" shows in display.



3. Press the **START/SPEEDY COOK** button.
   The oven light comes on and the turntable starts rotating.
   Warming starts and the time in the display will count down.

»STEAM CLEANING

This function uses steam to clean the inside of oven.
Before cleaning, put 150~200cc water in a mug cup or a small bowl and place it at the centre of the tray.



1. Press the **STEAM CLEANING** button. The STEAM indicator ( ) lights.
   The oven heats up for 10minutes.
   When heating up is complete the "door" "oPEn" blinks on the display.
   You may remove the mug cup and use the moisture in the oven to clean the inside of oven cavity.

2. After heating up ends, "door" "oPEn" shows on the display for 5 minutes.
   Once it passes 5minutes, automatic cooling mode starts.

NOTE

High temperature in the inside of oven may reduce the effect of steam power.
Cool it down to the room temperature before use.

»REMINDER MODE (Function to remind cooking complete)

To remind you that you have food in the oven, the oven will beep once a minute until you either open the oven door or press any button.

OPERATION

»COOKING TECHNIQUES

STANDING TIME
Dense foods e.g. meat, jacket potatoes and cakes, require standing time(inside or outside of the oven) after cooking, to allow heat to finish conducting to cook the centre completely. Wrap meat joints and jacket potatoes in aluminium foil while standing. Meat joints need approx. 10-15 minutes, jacket potatoes 5 minutes. Other foods such as plated meal, vegetables, fish etc require 2-5 minutes standing. After defrosting food, standing time should also be allowed. If food is not cooked after standing time, return to the oven and cook for additional time.

MOISTURE CONTENT
Many fresh foods e.g. vegetables and fruit, vary in their moisture content throughout the season, particularly jacket potatoes. For this reason cooking times may have to be adjusted. Dry ingredients e.g. rice, pasta, can dry out during storage so cooking times may differ.

DENSITY
Porous airy foods heat more quickly than dense heavy foods.

CLING FILM
Cling film helps keep the food moist and the trapped steam assists in speeding up cooking times. Pierce before cooking to allow excess steam to escape. Always take care when removing cling film from a dish as the build-up of steam will be very hot.

SHAPE
Even shapes cook evenly. Food cooks better by microwave when in a round container rather than square.

SPACING
Foods cook more quickly and evenly if spaced apart. NEVER pile foods on top of each other.

STARTING TEMPERATURE
The colder the food, the longer it takes to heat up. Food from a fridge takes longer to reheat than food at room temperature.

LIQUIDS
All liquids must be stirred before and during heating. Water especially must be stirred before and during heating, to avoid eruption. Do not heat liquids that have previously been boiled. DO NOT OVERHEAT.

TURNING & STIRRING
Some foods require stirring during cooking. Meat and poultry should be turned after half the cooking time.

ARRANGING
Individual foods e.g. chicken portions or chops, should be placed on a dish so that the thicker parts are towards the outside.

QUANTITY
Small quantities cook faster than large quantities, also small meals will reheat more quickly than large portions.

PIERCING
The skin or membrane on some foods will cause steam to build up during cooking. These foods must be pierced or a strip of skin should be peeled off before cooking to allow the steam to escape. Eggs, potatoes, apples, sausages etc, will all need to be pierced before cooking. DO NOT ATTEMPT TO BOIL EGGS IN THEIR SHELLS.

COVERING
Cover foods with microwave cling film or a lid. Cover fish, vegetables, casseroles, soups. Do not cover cakes, sauces, jacket potatoes or pastry items.

defrosting roasts fat-side-down.

- ▶ The shape of the package alters the defrosting time. Shallow rectangular shapes defrost more quickly than a deep block.
- ▶ After 1/3 of the defrost time has elapsed, check the food. You may wish to turn over, break apart, rearrange or remove thawed portions of the food.
- ▶ During defrost, the oven will prompt you to turn the food over. At this point, open oven door and check the food. Follow the techniques listed below for optimum defrost results. Then, close oven door, touch the START pad to complete defrosting.

Poultry and fish may be placed under running cool water until defrosted

- ☞ ***Turn over*** : Roast, ribs, whole poultry, turkey breasts, hot dogs, sausages, steaks, or chops.
- ☞ ***Rearrange*** : Break apart or separate steaks, chops, hamburger patties, ground meat, chicken or seafood pieces, chunks of meat such as stew beef.
- ☞ ***Shield*** : Use small strips of aluminum foil to protect thin areas or edges of unevenly shaped foods such as chicken wings. To prevent arcing, do not allow foil to come within 1-inch of oven walls or door.
- ☞ ***Remove*** : To prevent cooking, thawed portions should be removed from the oven at this point. This may shorten defrost time for food weighing less than 3 lbs.(1350g).

Cooking chart

Item		Power Level	Cooking Time Per lb./450g	Special Instruction
MEAT				
Beef joint	-Rare	P-80	6-8 min.	- Chilled meat and poultry should be removed from the refrigerator at least 30 minutes before cooking. - Always let the meat and poultry stand, covered after cooking.
	-Medium	P-80	7-9 min.	
	-well done	P-80	9-11 min.	
Pork Joint		P-HI	10-13 min.	
Bacon joint		P-HI	8-10 min.	
POULTRY				
Whole chicken		P-HI	4-9 min.	
Portions chicken		P-80	5-7 min.	
Breast (boned)		P-80	6-8 min.	
FISH				
Fish Fillets		P-HI	3-5 min.	- Brush a little oil or melted butter over the fish, or add 15~30ml(1-2 tbsp) lemon juice, wine, stock, milk or water. - Always let the fish stand, covered, after cooking
Whole Mackerel, Cleaned and prepared		P-HI	3-5 min.	
Whole Trout, Cleaned & Prepared		P-HI	4-6 min.	
Salmon steaks		P-HI	4-6 min.	

NOTE : The above times should be regarded only as a guide. Allow for difference in individual tastes and preferences. The times may vary due to the shape, cut, and composition of the food. Frozen meat, poultry and fish must be thoroughly thawed before cooking.

OPERATION

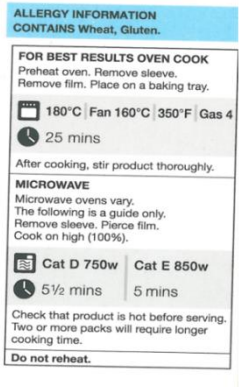
»COOKING & REHEATING CHART

Reheating chart

- Baby food particularly needs to be checked carefully before serving to prevent burns.
- When heating pre-packaged ready-cooked foods, always follow the pack instructions carefully.
- If you freeze foods which were bought from the fresh or chilled counters, remember that they should be thoroughly thawed before following the heating instructions on the packet. It's worth putting a note on them so that other members of the household will remember too.
- Remember to remove metal ties and transfer all food from foil containers before reheating.
- Chilled(refrigerated) food takes longer to reheat than food at room temperature (such as just-cooled food or food from the store cupboard).
- All foods should be reheated using full microwave power.

Item	Cooking time	Special Instructions
Baby food 128g jar	20 sec.	Empty into a small serving bowl. Stir well once or twice during heating. Before serving, check the temperature carefully.
Baby milk 100ml / 4fl.oz. 225ml / 8fl.oz.	20-30 sec. 40-50 sec.	Stir or shake well and pour into a sterilized bottle. Before serving, shake well and check the temperature carefully.
Sandwich roll or bun 1 roll	20-30 sec.	Wrap in paper towel and place on glass microwaveable rack. ***Note : Do not use recycled paper towels as it may contain metal particles.**
Lasagna 1 serving (10 1/2 oz./300g)	4-6 min.	Place lasagna on microwaveable plate. Cover with plastic wrap and vent.
Casserole 1 cup 4 cups	1 1/2-3 min. 5-7 min.	Cook covered, in a microwaveable dish. (casserole) Stir once halfway through cooking.
Mashed potatoes 1 cup 4 cups	2-3 min. 6-8 min.	Cook covered, in a microwaveable dish. (casserole) Stir once halfway through cooking.
Baked beans 1 cup	2-3 min.	Cook covered, in a microwaveable dish. (casserole) Stir once halfway through cooking.
Ravioli or pasta in sauce 1 cup 4 cups	2-3 min. 6-9 min.	Cook covered, in a microwaveable dish. (casserole) Stir once halfway through cooking.

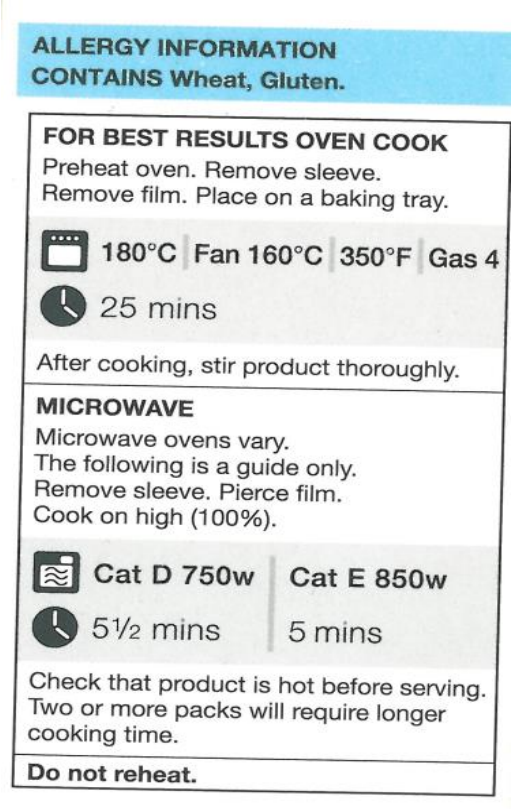

do not iron over fastenings
wash with colour protective detergent
iron while damp
ne pas repasser sur les fermetures
laver avec un détergent de protection des couleurs
repasser encore humide
no planchar sobre los cierres
lavar con un detergente protector de los colores
planchar en húmedo


ALLERGY INFORMATION
CONTAINS Wheat, Gluten.
FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve.
Remove film. Place on a baking tray.
180°C | Fan 160°C | 350°F | Gas 4
25 mins
After cooking, stir product thoroughly.
MICROWAVE
Microwave ovens vary.
The following is a guide only.
Remove sleeve. Pierce film.
Cook on high (100%).
Cat D 750w | Cat E 850w
5½ mins | 5 mins
Check that product is hot before serving.
Two or more packs will require longer cooking time.
Do not reheat.


THE WHITE COMPANY
LONDON
100% COTTON
Wash dark colours separately
Wash before use


HOME
LAURA ASHLEY


MARKS & SPENCER
FULLER LONGER
HIGH PROTEIN + BALANCED CARBS + CALORIES 400 PER PACK
Chicken & vegetable hotpot
with a vegetable & lentil gravy
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVING SUGGESTION
10/01/2013


ALLERGY INFORMATION
CONTAINS Wheat, Gluten.
FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve.
Remove film. Place on a baking tray.
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Remove sleeve. Pierce film.
Cook on high (100%).
Cat D 750w | Cat E 850w
5½ mins | 5 mins
Check that product is hot before serving.
Two or more packs will require longer cooking time.
Do not reheat.

Gekookte gemarineerde gambe's bevatten gambe's (10%) · water · zonnebloemolie · peterselie · zout · knoflookpuree · maïzena · citroensap · gekneusde zwarte peper · zuurregelaar: natriumwaterstofcarbonaat.
ALLERGIE-INFORMATIE Bevat kreeftachtigen, eieren, vis, schaaldieren, tarwe, gluten.

PAN Wikkel en folie verwijderen. Inhoud van het pak in de pan doen en 2 eetlepels water toevoegen. Product gedurende 3-4 minuten op matig vuur opwarmen en langzaam roeren tot de pasta met saus is bedekt. Matige temperatuur, 3 tot 4 minuten. Voor het serveren controleren of het product warm is. Niet opnieuw verwarmen.
BEWAARADVIES Te gebruiken tot: zie voorzijde verpakking. Bewaren bij: 0 tot 5 °C. Niet geschikt om in te vriezen.

lemon and parsley marinated king prawns and Italian linguine in a creamy cheese sauce

FOR BEST RESULTS MICROWAVE
Microwave ovens vary. The following is a guide only. Remove sleeve. Pierce film. Cook on high (100%).

Cat D 750w	Cat E 850w
3 mins	2½ mins

Allow to stand for 1 minute. After cooking, stir product thoroughly. Check that product is hot before serving. Two or more packs will require longer cooking time.

HOB Remove sleeve and film. Add contents of pack to pan and add 2 tablespoons of water. Heat over a medium heat for 3-4 minutes, stirring gently until sauce is coating the pasta.

3-4 mins

Check that product is hot before serving.

Do not reheat.

INGREDIENTS Cooked Linguine Pasta (50%) · Single Cream (14%) · Cooked Marinated King Prawns (13%) · Water · Extra Mature Cheddar Cheese (3%) · White Wine · Grana Padano Cheese (contains Preservative: Lysozyme (from Egg)) · Lemon Juice · Cornflour · Parsley · Salt · Fish Gelatine · Garlic Purée · Cracked Black Pepper.

Cooked Linguine Pasta contains Durum Wheat Semolina · Water · Sunflower Oil.

Cooked Marinated King Prawns contain King Prawns (10%) · Water · Sunflower Oil · Parsley · Salt · Garlic Purée · Cornflour · Lemon Oil · Cracked Black Pepper · Acidity Regulator: Sodium Bicarbonate

ALLERGY INFORMATION
CONTAINS Cow's Milk, Eggs, Fish, Shellfish, Wheat, Gluten.

NO ARTIFICIAL COLOURS OR ARTIFICIAL FLAVOURINGS

IMPORTANT
Although extra care has been taken to remove all shell, some small pieces may remain.
Care should be taken when removing product from microwave, as packaging may soften slightly.

380g e

NUTRITION	
Typical values/Valeurs moyennes/Gemi	
Energy kJ/Energie/Energie	
Energy kcal	
Protein/Protéines/Eiwitten	
Carbohydrate/Glucides/Koolhydraten	
of which sugars/dont sucres/waarv	
Fat/Lipides/Vetten	
of which saturates/dont saturés/wa	
Fibre/Fibres alimentaires/Voedingsvezels	
Sodium/Sodium/Natrium	
Equivalent as salt/Équivalent en sal	

Guideline daily amounts - adult
Cals 2000 | Fat 70g | S

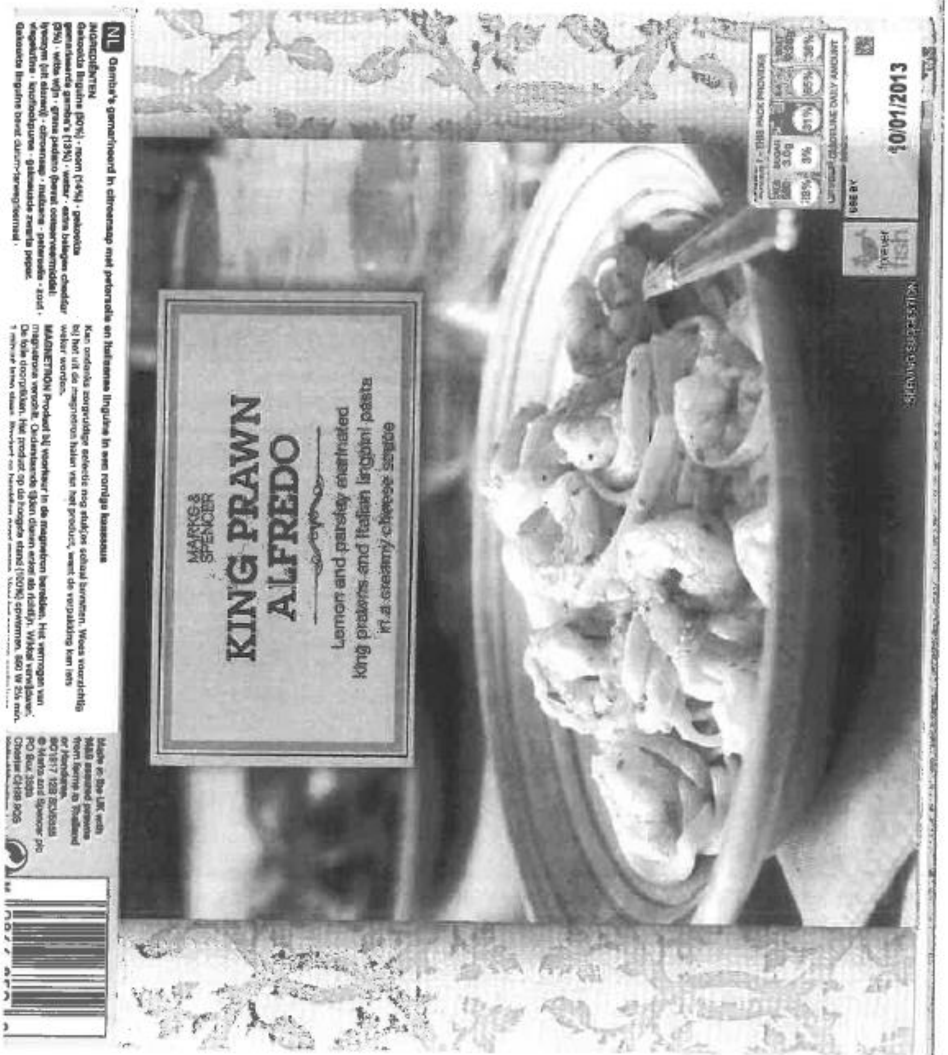
STORAGE
For Use By, see front of pa
0°C to +5°C. Not suitable f

F **pâtes linguine italiennes et crevettes roses royales marinées au citron et au persil dans une sauce crémeuse au fromage**

INGRÉDIENTS Pâtes linguine cuites (50 %) · Crème (14 %) · Crevettes roses royales marinées cuites (13 %) · Eau · Fromage cheddar longuement affiné (3 %) · Vin blanc · Fromage Grana Padano (contient Conservateur : lysozyme d'œuf) · Jus de citron · Farine de maïs · Persil · Sel · Gélatine de poisson · Purée d'ail · Poivre noir concassé.
Pâtes linguine cuites contient Semoule de blé dur · Eau · Huile de tournesol.
Crevettes roses royales marinées cuites contient Crevettes roses royales (10 %) · Eau · Huile de tournesol · Persil · Sel · Purée d'ail · Farine de maïs · Huile de citron · Poivre noir concassé · Correcteur d'acidité : bicarbonate de sodium.
ALLERGÈNES Contient lait de vache, œufs, poisson, crustacés, blé, gluten.

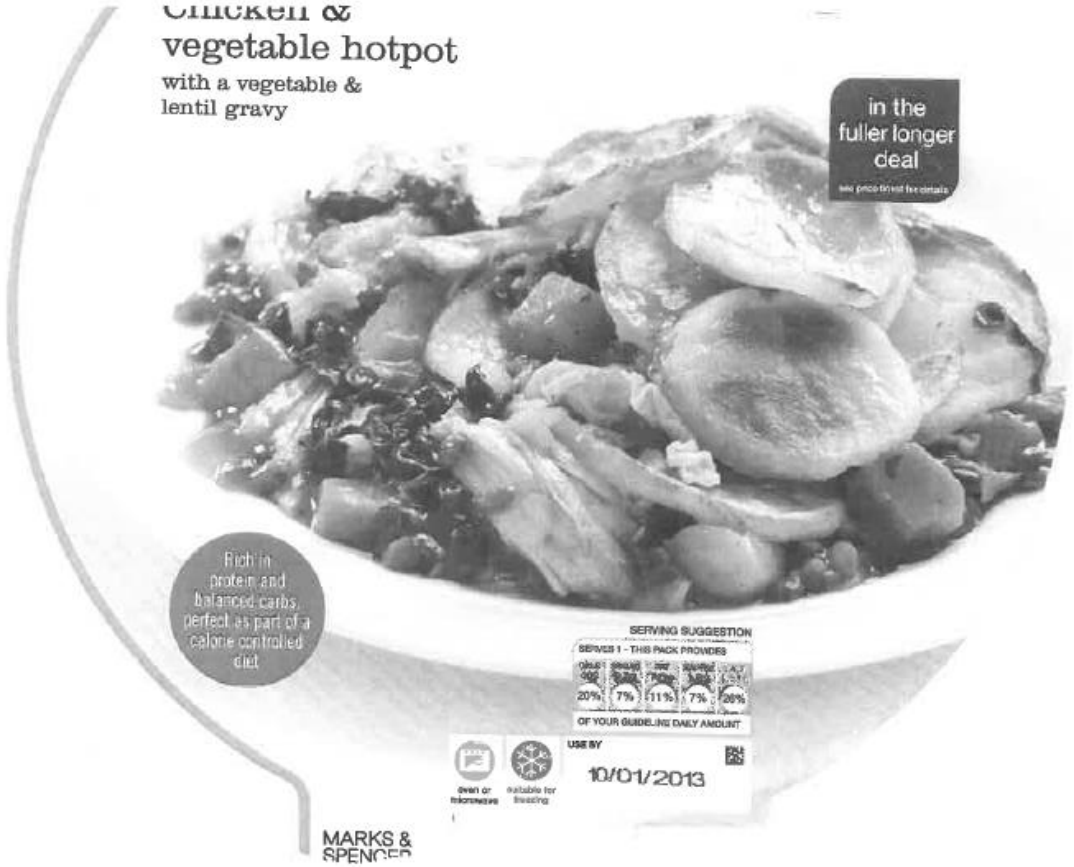
Peut contenir des fragments de coquille. Faire attention en sortant le produit d
peut avoir légèrement ramolli.
MICRO-ONDES Cuire de préférence au micro-ondes. La puissance des micro-on
donné à titre indicatif uniquement. Retirer l'emballage. Percer le film. Cuire à pleine p
Laisser reposer pendant 1 minute. Après la cuisson, bien mélanger le produit. Vérifie
de servir. Un temps de cuisson plus important sera nécessaire pour plusieurs produi
POÊLE Retirer l'emballage et le film. Verser le contenu du paquet dans une casserol
d'eau. Faire chauffer à feu moyen pendant 3 à 4 min., en remuant délicatement jusq
pâtes. Feu moyen 3–4 min. Vérifier que le produit est chaud avant de servir. Ne pas
CONSERVATION À consommer jusqu'au : voir le devant du paquet. Conserver au r
Ne pas congeler.

51


MARKS & SPENCER
KING PRAWN ALFREDO
Lemon and parsley marinated king prawns and Italian linguini pasta in a creamy cheese sauce
USE BY
10/01/2013
forever fish
SERVING SUGGESTION

JH


MARKS & SPENCER
FULLER LONGER
Chicken & vegetable hotpot
in the fuller longer deal
Kelp Stock contains Water · Kelp.
Mushroom Stock contains Mushrooms · Water · Sugar · Salt · Rapeseed
Oil · Dried mushrooms.
ALLERGY INFORMATION
CONTAINS Wheat, Gluten
NUTRITION
FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve.
Remove film. Place on a baking tray.
180°C Fan 160°C 350°F Gas 4
25 mins
After cooking, stir product thoroughly.
MICROWAVE
Microwave ovens vary.
The following is a guide only.
Remove sleeve. Pierce film.
Cook on high (100%).
Cat D 750w
5½ mins
Cat E 850w
5 mins
Check that product is hot before serving.
Then cook more pieces will require longer cooking time.
Do not reheat.


Chicken &
vegetable hotpot
with a vegetable &
lentil gravy
in the
fuller longer
deal
Rich in
protein and
balanced carbs,
perfect as part of a
calorie controlled
diet
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
20%
7%
11%
7%
20%
OF YOUR GUIDELINE DAILY AMOUNT
USE BY
10/01/2013
oven or
microwave
suitable for
freezing
MARKS &

MC


MARKS & SPENCER
3 for £6
VEGETARIAN
ROASTED BUTTERNUT SQUASH LASAGNE
Sage roasted butternut squash and spinach in a rich tomato sauce with goat's cheese béchamel
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
22% 16% 22% 27% 39%
OF YOUR GUIDELINE DAILY AMOUNT
USE BY
13/01/2013

MofC


Chicken & vegetable hotpot
with a vegetable & lentil gravy
PROTEIN + CARBS + 400 PER PACK
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
20% 7% 11% 7% 26%
OF YOUR GUIDELINE DAILY AMOUNT
oven or microwave
suitable for freezing
USE BY
10/01/2013

Roast Chicken Stock contains Water · Chicken Bones · Onions · Carrots · Leeks · Garlic · Parsley · Bay Leaves · White Peppercorns.

Kelp Stock contains Water · Kelp.

Mushroom Stock contains Mushrooms · Water · Sugar · Salt · Rapeseed Oil · Dried Mushrooms.

ALLERGY INFORMATION
CONTAINS Wheat, Gluten

FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve.
Remove film. Place on a baking tray.

180°C | Fan 160°C | 350°F | Gas 4

25 mins

After cooking, stir product thoroughly.

MICROWAVE
Microwave ovens vary.
The following is a guide only.
Remove sleeve. Pierce film.
Cook on high (100%).

Cat D 750w	Cat E 850w
5½ mins	5 mins

Check that product is hot before serving. Two or more packs will require longer cooking time.

Do not reheat.

NUTRITION Typical values/Waarin zitten/Gemiddelde waarden	per 100g	per 420g pack
Energy kJ Energie/Energie	395	1660
Energy kcal	95	400
Protein Proteïne/Eiwitten	8.1g	34.0g
Carbohydrate Glucides/Koolhydraten	10.0g	42.0g
of which sugars dont sucres/waarvan suikers	1.6g	6.7g
Fat Lipides/Vetten	1.8g	7.6g
of which saturates dont saturés/waarvan verzadigd	0.3g	1.3g
Fibre. Fibre alimentaire/Voedingsvezels	2.4g	10.1g
Sodium Sodium/Natrium	0.15g	0.63g
Equivalent as salt Equivalent en sel/zout	0.38g	1.58g

Guideline daily amounts - adult			
Cals 2000	Fat 70g	Sat Fat 20g	Salt 6g

We have worked with nutrition scientists to create the Fuller Longer range. Each meal within the range is high in protein and with balanced carbohydrate.

You can find out more information about the science behind the range and a balanced approach to diet and lifestyle online.

marksandspencer.com/health

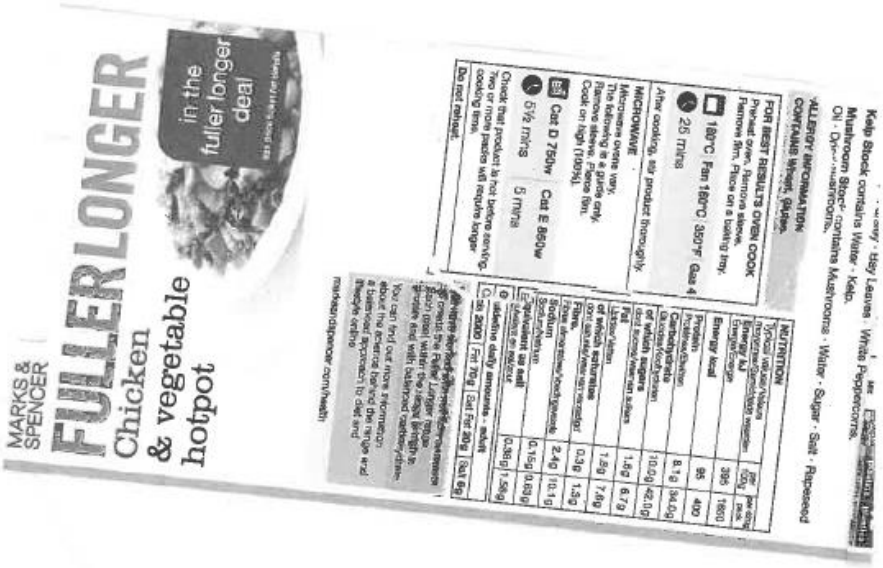
in the fuller longer deal

FULLER LONGER

Chicken & vegetable hotpot

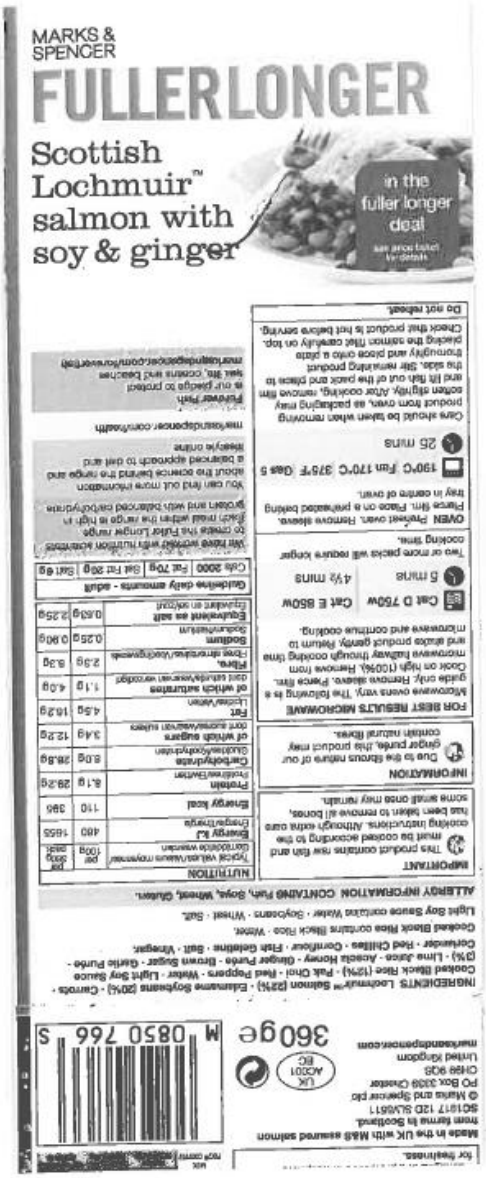
MARKS & SPENCER

AD


MARKS & SPENCER
FULLER LONGER
Chicken
& vegetable
hotpot
in the fuller longer deal
Kelp Stock contains Water · Bay Leaves · White Peppercorns.
Mushroom Stock contains Mushrooms · Water · Sugar · Salt · Rapeseed
ALLERGY INFORMATION
CONTAINS Wheat, Celery.
FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve.
Remove film. Place on a baking tray.
180°C Fan 160°C 350°F Gas 4
25 mins
Allow cooking, stir product thoroughly.
MICROWAVE
Microwave ovens vary.
The following is a guide only.
Remove sleeve, pierce film.
Cook on high (1000W).
Cat D 750W
5½ mins
Cat E 850W
5 mins
Check that product is hot before serving.
Two or more packs will require longer cooking time.
Do not reheat.
NUTRITION
Typical values/Valeurs
Energy kJ
Energy Kcal
Energy
Protein
Carbohydrate
of which sugars
Fat
of which saturates
Fibre
Sodium
Sodium/Natrium
Salt equivalent as sodium
Sel équivalent au sodium
Cals 2000
Fat 70g
Sat Fat 20g
Sugars 90g
You can find out more information about the ingredients and nutrition and a balanced approach to diet and lifestyle online
marksandspencer.com/health


HIGH PROTEIN + BALANCED CARBS + CALORIES 400 PER PACK
Chicken & vegetable hotpot
with a vegetable & lentil gravy
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
20%
7%
11%
7%
OF YOUR GUIDELINE DAILY AMOUNT
USE BY
09/01/2013
suitable for freezing

DH


MARKS & SPENCER
FULLER LONGER
Scottish Lochmuir™ salmon with soy & ginger
in the fuller longer deal
INGREDIENTS Lochmuir™ Salmon (22%) · Edamame Soybeans (20%) · Carrots · Cooked Black Rice (12%) · Pak Choi · Red Peppers · Water · Light Soy Sauce (3%) · Lime Juice · Acacia Honey · Ginger Purée · Brown Sugar · Garlic Purée · Coriander · Red Chillies · Cornflour · Fish Gelatine · Salt · Vinegar.
Cooked Black Rice contains Black Rice · Water.
Light Soy Sauce contains Water · Soybeans · Wheat · Salt.
ALLERGY INFORMATION CONTAINS Fish, Soya, Wheat, Gluten.
NUTRITION
Typical values/Valores típicos/Gemiddelde waarden
per 100g
per 350g bag
Energy kJ 480 1655
Energy kcal 110 386
Protein 8.1g 28.2g
Carbohydrate 5.0g 28.8g
of which sugars 3.4g 12.2g
Fat 4.6g 16.2g
of which saturates 1.1g 4.0g
Fibre 2.3g 8.3g
Sodium 0.25g 0.90g
Equivalent as salt 0.63g 2.25g
Guideline daily amounts - adult
Calc 2000 | Fat 70g | Sat Fat 20g | Sat 6g
IMPORTANT
This product contains raw fish and must be cooked according to the cooking instructions. Although extra care has been taken to remove all bones, some small ones may remain.
INFORMATION
Due to the fibrous nature of our ginger purée, this product may contain natural fibres.
FOR BEST RESULTS MICROWAVE
Microwave ovens vary. The following is a guide only. Remove from sleeve. Pierce film. Cook on high (1000W) Remove from microwave (allow through cooking time and allow product gently. Return to microwave and continue cooking.
Cal D 750W | Cal E 850W
5 mins | 4½ mins
Two or more packs will require longer cooking time.
OVEN Preheat oven. Remove sleeve. Pierce film. Place on a preheated baking tray in centre of oven.
190°C Fan 170°C 375°F Gas 5
25 mins
Care should be taken when removing product from oven, as packaging may soften slightly. After cooking, remove film and lift fish out of the pack and place to one side. Stir remaining product thoroughly and place onto a plate placing the salmon fillet carefully on top. Check that product is hot before serving.
Do not reheat.
We have worked with nutrition advisors to create the Fuller Longer range. Each meal within the range is high in protein and low saturated fat.
You can find out more information about the science behind the range and a balanced approach to diet and lifestyle online
marksandspencer.com/fuller
Further Path
is our pledge to protect the sea, oceans and beaches
marksandspencer.com/ourpath
Made in the UK with M&S sourced salmon
from farms in Scotland.
SC0177 12D SLV6611
© Marks and Spencer plc
PO Box 3339 Chester
CH99 9GB
United Kingdom
marksandspencer.com
UK ACCOO1 EC
360ge
M 0850 766 S

DH


MARKS & SPENCER
FULLER LONGER
HIGH PROTEIN
BALANCED CARBS
CALORIES 395 PER PACK
Scottish Lochmuir™ salmon with soy & ginger
with soybeans, black rice and a sweet soy & ginger dressing
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVES 1 - THIS PACK PROVIDES
OF YOUR GUIDELINE DAILY AMOUNT
forever fish
2
cook
10/01/2013


MARKS & SPENCER
FULLER LONGER
Chicken
& vegetable
hotpot
in the fuller longer deal
Kelp Stock contains Water · Kelp.
Mushroom Stock contains Mushrooms · Water · Sugar · Salt · Rapeseed
Oil · Dried mushrooms.
ALLERGY INFORMATION
CONTAINS WHEAT, CELERY
FOR BEST RESULTS OVEN COOK
Preheat oven. Remove sleeve. Remove film. Place on a baking tray.
180°C Fan 160°C 350°F Gas 4
25 mins
After cooking, stir product thoroughly.
MICROWAVE
Microwave ovens vary. The following is a guide only. Remove sleeve. Remove film. Place film. Cook on high (1000W).
Cat D 750w
5½ mins
Cat E 850w
5 mins
Check that product is hot before serving. Two or more pieces will require longer cooking time.
Do not reheat.
NUTRITION
Typical values/Valeurs Energy/Energie kJ Energy/Energie kcal
Energy kcal
Protein
Carbohydrate
of which sugars
Fat
of which saturates
Fibre
Sodium
Guideline daily amounts - adult
Per 100g
385
91
8.1g
10.0g
1.6g
1.8g
0.3g
2.4g
0.15g
0.38g
Per 400g
1600
400
34.0g
42.0g
6.7g
7.6g
1.2g
10.1g
0.63g
1.58g
GDA 2000 | Fat 70g | Sat Fat 20g | Salt 6g
marksandspencer.com/health


HIGH PROTEIN + BALANCED CARBS + CALORIES 400 PER PACK
Chicken & vegetable hotpot
with a vegetable & lentil gravy
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
20% 7% 11% 7% 26%
OF YOUR GUIDELINE DAILY AMOUNT
USE BY
09/01/2013
oven or microwave
suitable for freezing

Keep refrigerated 0°C to +5°C.
Not suitable for freezing.

Packaged in a protective atmosphere for freshness.

Made in the UK with cod from the North East Atlantic. SC6275
© Marks and Spencer plc
PO Box 3339 Chester CH99 9QS
United Kingdom
marksandspencer.com

UK LI030 EC

390g ℮

M 0709 569 S

INGREDIENTS

Mashed Potato (33%) · Cod Loin (24%) · Peas (12%) · Green Beans (7%) · Water · Fish Stock · Extra Mature Cheddar Cheese (3%) (contains Potato Starch) · Semi-Skimmed Milk · Whole Milk · Onions · Low Fat Hard Cheese (contains Potato Starch) · Cornflour · Dijon Mustard · Tapioca Starch · Parsley · Rapeseed Oil · Fish Gelatine · Salt · Lactose · Ground White Pepper.

Mashed Potato contains Potatoes · Semi-Skimmed Milk · Double Cream · Unsalted Butter · Salt.

Fish Stock contains Water · Fish Bones · Carrots · Onions · White Wine · Dried Thyme · Dried Parsley · Ground Black Pepper.

Dijon Mustard contains Water · Mustard Flour · Vinegar · Sea Salt · Mustard Husk · Ground Pimentoes · Ground Turmeric.

ALLERGY INFORMATION

CONTAINS Cow's Milk, Fish, Mustard.

Not suitable for SHELLFISH allergy sufferers due to manufacturing methods used.

IMPORTANT

This product contains raw fish and must be cooked according to the cooking instructions. Although extra care has been taken to remove all bones, some small ones may remain.

FOR BEST RESULTS MICROWAVE

Microwave ovens vary. The following is a guide only. Remove sleeve. Pierce film. Cook on high (100%).

Cat D 750w	Cat E 850w
4½ mins	4 mins

After heating, allow product to stand for 1 minute. Two or more packs will require longer cooking time.

OVEN

Preheat oven. Remove sleeve. Pierce film. Place in centre of oven on a baking tray.

190°C | Fan 170°C | 375°F | Gas 5

30 mins

Check that product is hot before serving.

Do not reheat.

NUTRITION

Typical values/Valeurs moyennes/Gemiddelde waarden	per 100g	per 390g pack
Energy kJ Energie/Energie	335	1305
Energy kcal	80	310
Protein Protéines/Eiwitten	6.2g	24.2g
Carbohydrate Glucides/Koolhydraten	6.8g	26.5g
of which sugars dont sucres/waarvan suikers	1.2g	4.7g
Fat Lipides/Vetten	2.6g	10.1g
of which saturates dont saturés/waarvan verzadigd	1.5g	5.9g
Fibre Fibres alimentaires/Voedingsvezels	2.2g	8.6g
Sodium Sodium/Natrium	0.16g	0.62g
Equivalent as salt Équivalent en sel/zout	0.40g	1.55g

Guideline daily amounts - adult

Cals 2000	Fat 70g	Sat Fat 20g	Salt 6g

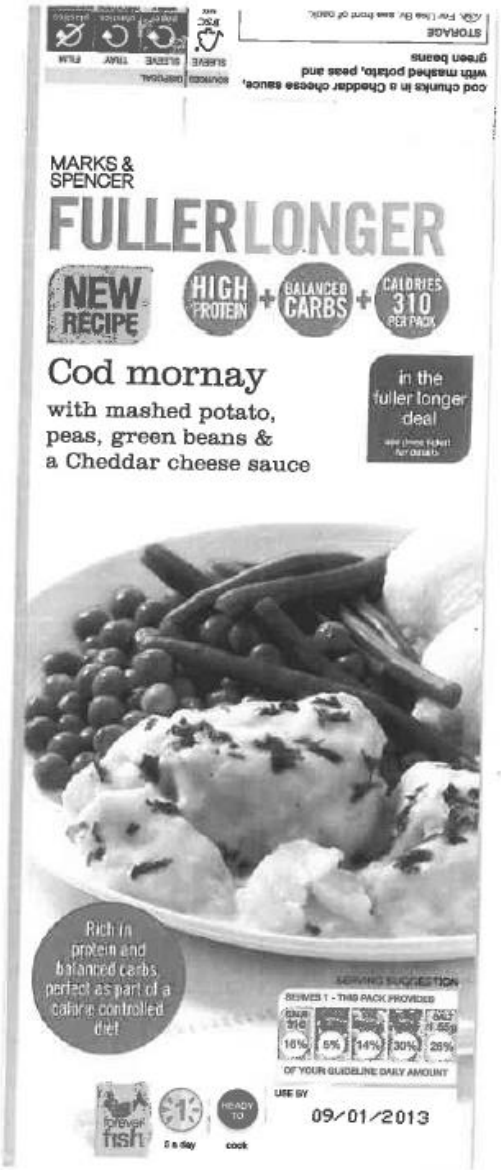
[illegible] Fuller Longer range [illegible] carbohydrate.

You can find out more information about the science behind the range and a balanced approach to diet and [illegible]

marksandspencer.com/health

[illegible]

JM


cod chunks in a Cheddar cheese sauce, with mashed potato, peas and green beans
STORAGE
SLEEVE
TRAY
FILM
MARKS & SPENCER
FULLER LONGER
NEW RECIPE
HIGH PROTEIN
BALANCED CARBS
CALORIES 310 PER PACK
Cod mornay
with mashed potato, peas, green beans & a Cheddar cheese sauce
in the fuller longer deal
Rich in protein and balanced carbs, perfect as part of a calorie controlled diet
SERVING SUGGESTION
SERVES 1 - THIS PACK PROVIDES
16%
6%
14%
30%
28%
OF YOUR GUIDELINE DAILY AMOUNT
forever fish
2 a day
READY TO cook
USE BY
09/01/2013

Appendix E
Participants' Traces

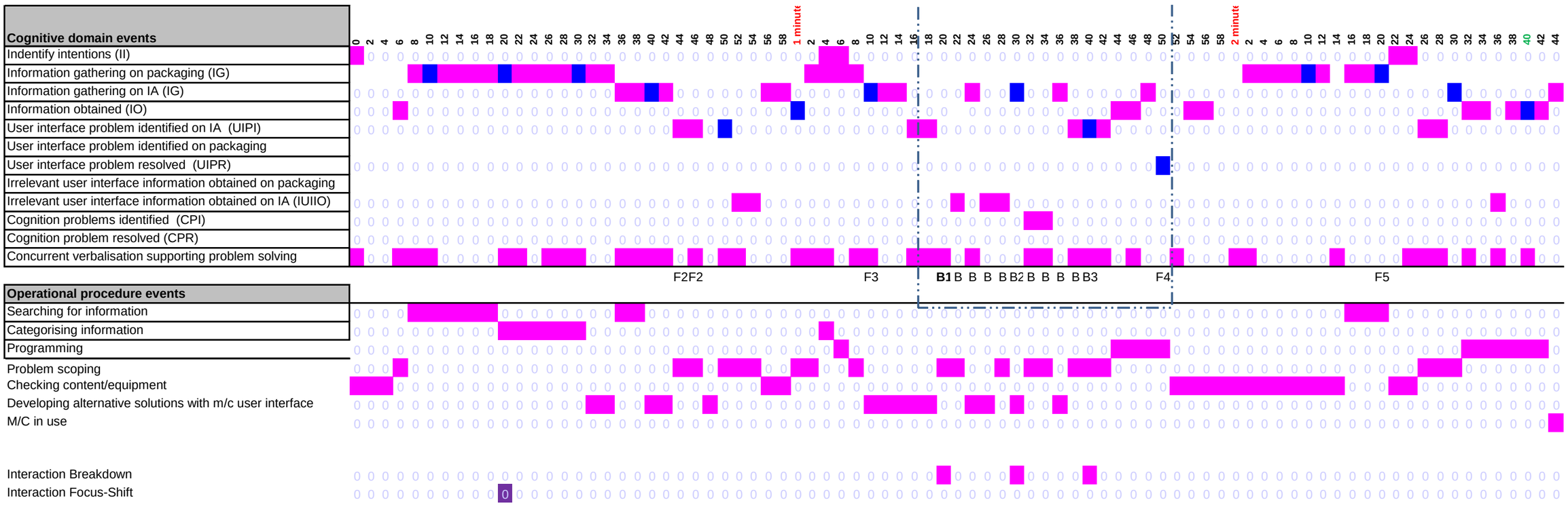


Figure A.1.6 MW's Traces Using the Microwave Oven (coded at two second intervals)

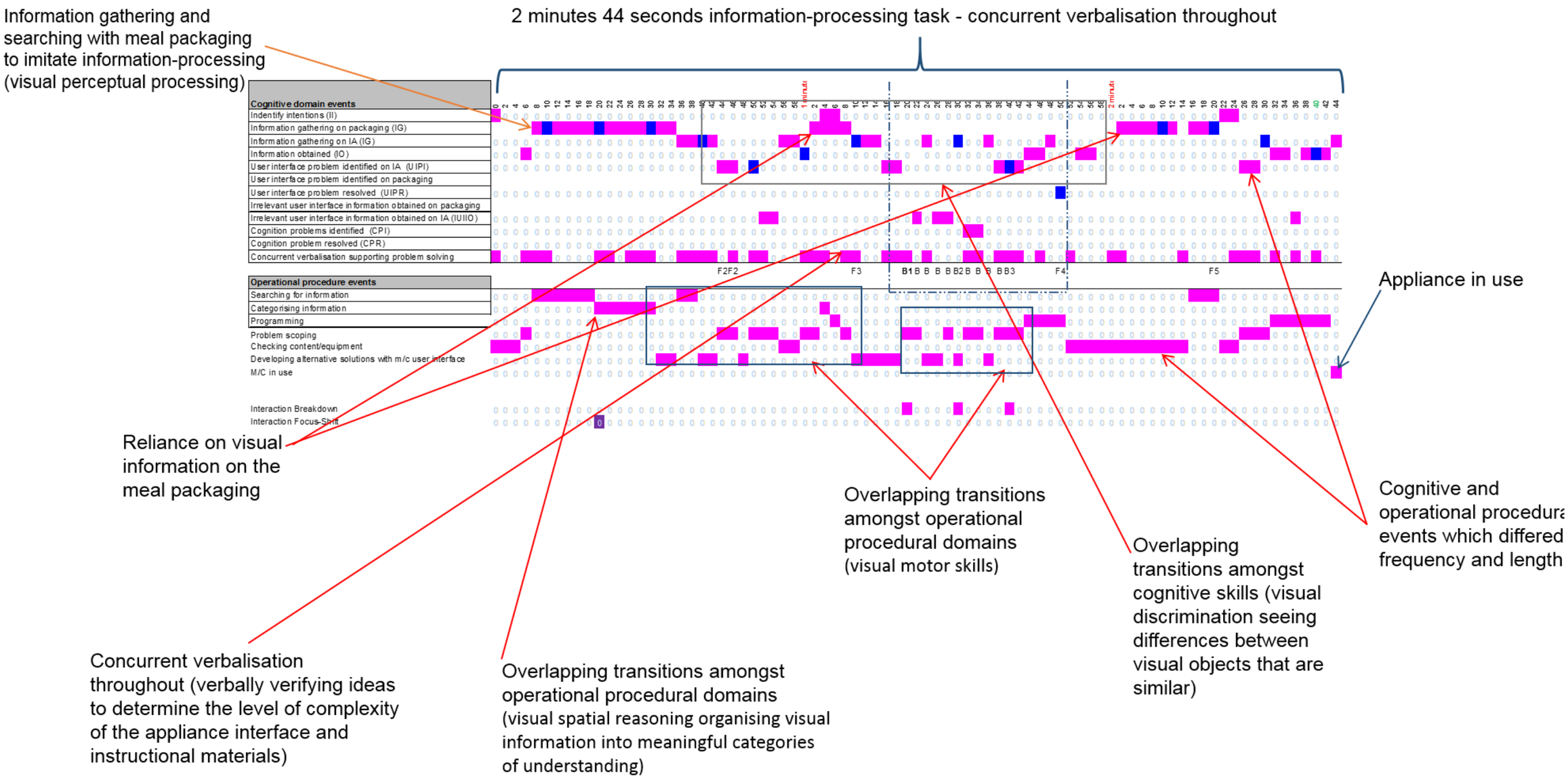


Figure A.1.7 MW's Traces Using the Microwave Oven (coded at two second intervals with annotations)

Name DH aged 65-67

Cognitive domain events
Indentify intentions
Information gathering on packaging
information gathering with the appliance instruction manual
Information gathering on information appliance
Information obtained
User interface problem identified on information appliance
User interface problem identified on packaging
User interface problem resolved
Irrelevant user interface information obtained on packaging
Irrelevant user interface information obtained on information appliance
Cognition problems identified
Cognition problem resolved
Concurrent verbalisation supporting problem solving

Operational procedure events
Searching for information
Categorising information
Programming
Problem scoping
Checking content/equipment/mcor utensils
Developing alternative solutions with m/c user interface
M/C in use

Impediments to workflow
Interaction Breakdown
Interaction Focus-Shift

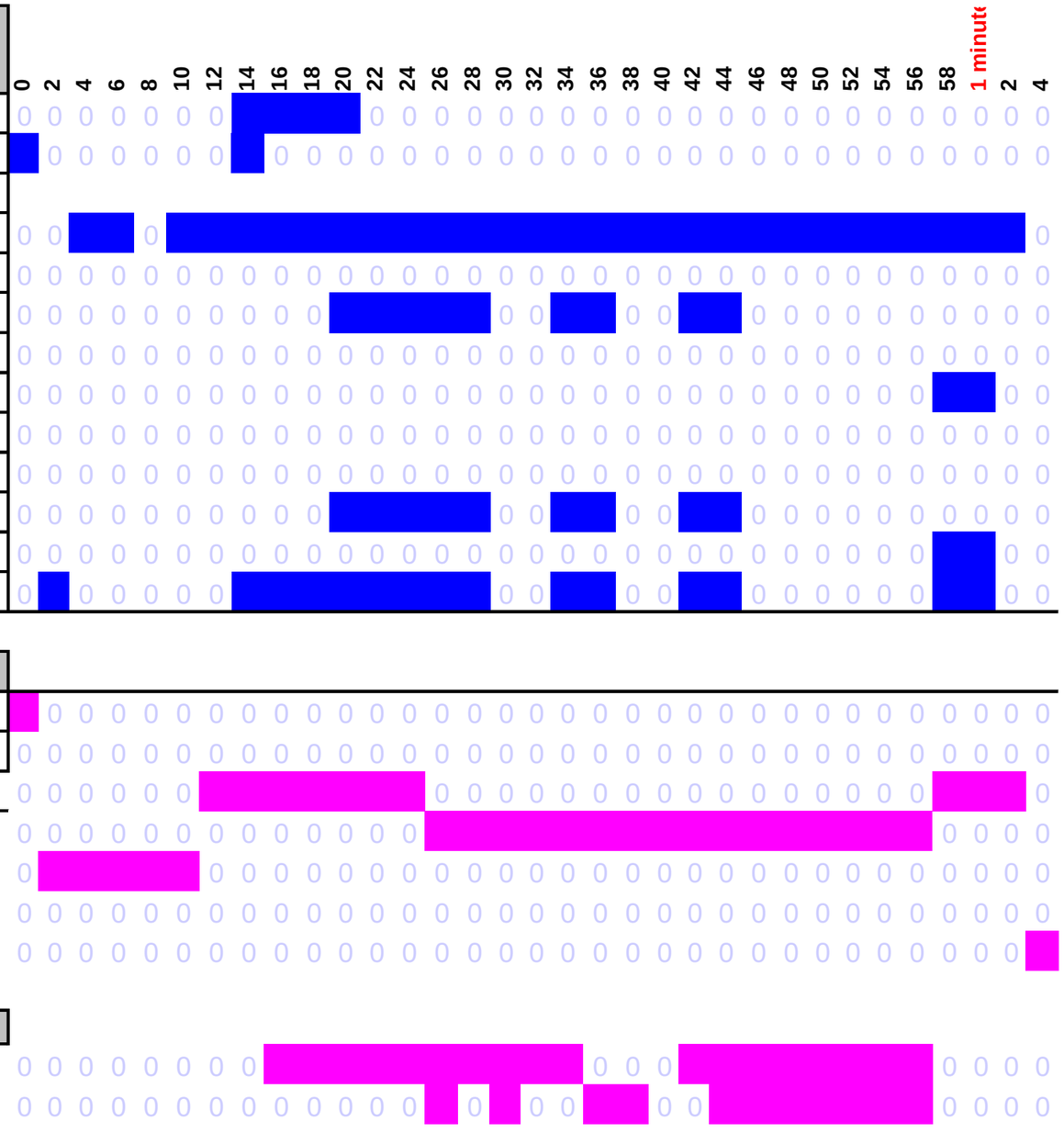


Figure A.1.8 DH's Traces using the Current Operational Interface (coded at two second intervals)

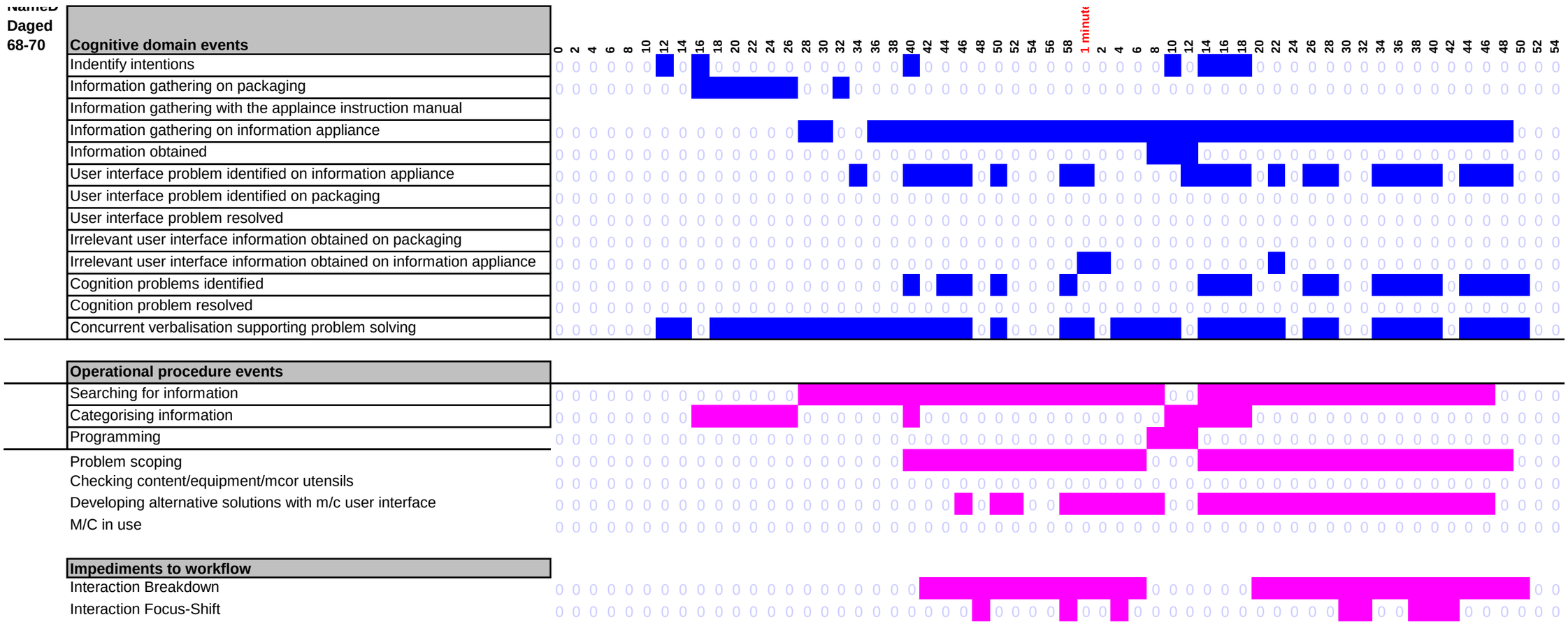


Figure A.1.9 AD's Traces using the Current Operational Interface (coded at two second intervals)

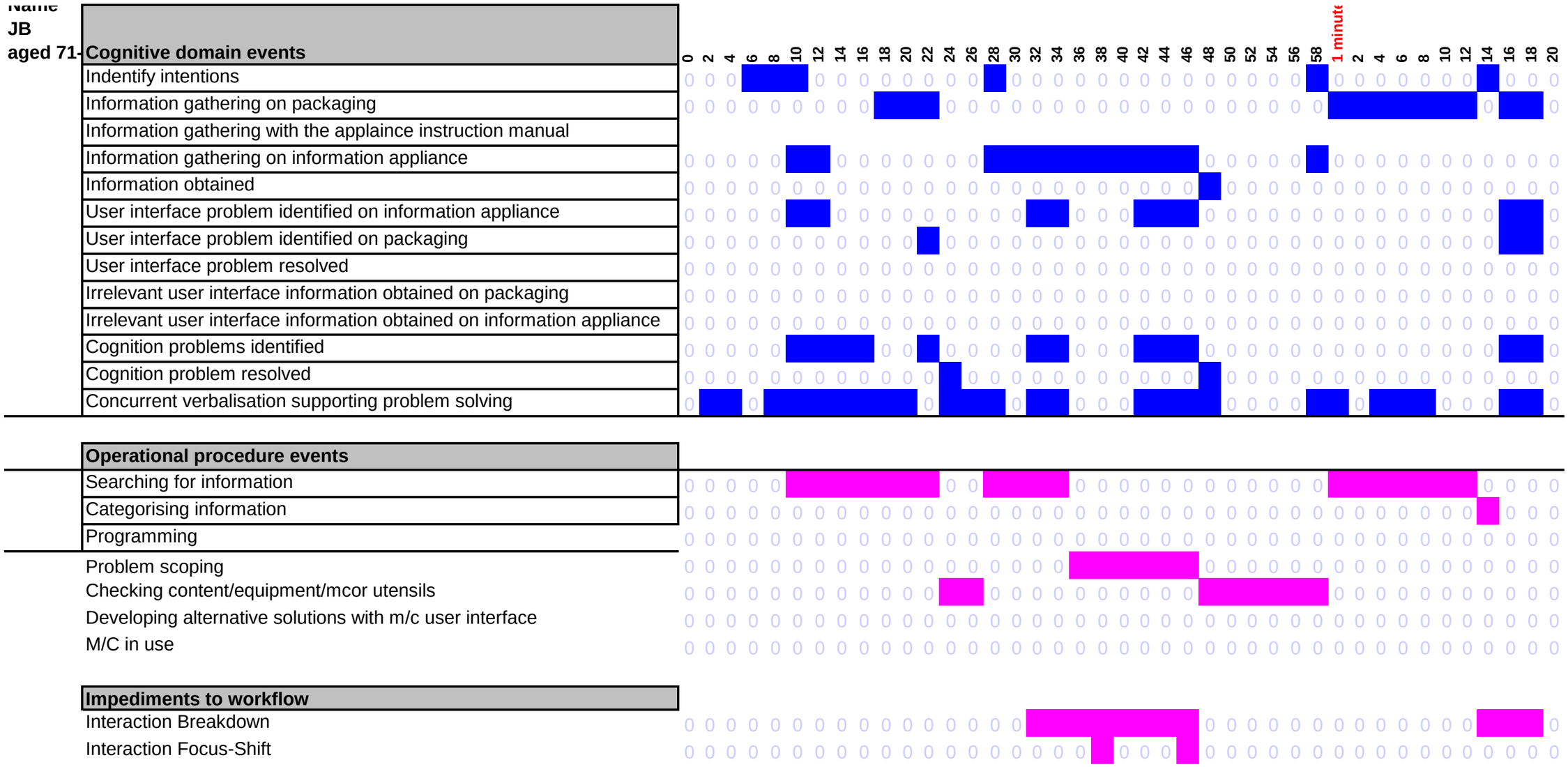


Figure A.1.10 JB's Traces using the Current Operational Interface (coded at two second intervals)

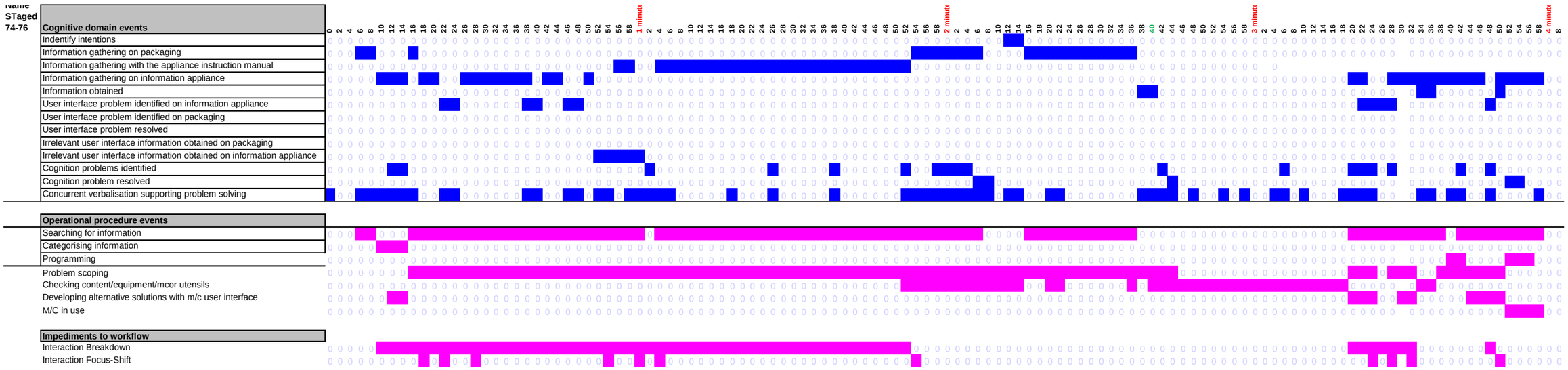


Figure A.1.11 ST's Traces using the Current Operational Interface (coded at two second intervals)

Name SLaged 65-67	Cognitive domain events	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56
	Indentify intentions	0	0	0	0	0	0	0	0	0	0	0	0	0	■	0	■	■	0	■	0	0	0	0	0	■	■	0	0	0
	Information gathering on packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Information gathering with the appliance instruction manual	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Information gathering on information appliance	0	0	0	0	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	0	0
	Information obtained	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	■	0	■	0	0	0	0	0	0	0
	User interface problem identified on information appliance	0	0	0	0	0	0	0	0	0	0	■	■	0	0	0	0	0	0	0	0	0	0	0	0	0	0	■	0	0
	User interface problem identified on packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	User interface problem resolved	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrelevant user interface information obtained on packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrelevant user interface information obtained on information appliance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Cognition problems identified	0	0	0	0	0	0	0	0	0	0	■	■	0	0	0	0	0	0	0	■	■	0	0	0	0	0	■	0	0
	Cognition problem resolved	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Visual cognition problem identified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Visual cognition problem resolved	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Concurrent verbalisation supporting problem solving	0	■	0	0	0	0	0	0	0	0	■	■	0	■	0	■	■	0	■	■	■	0	0	0	■	0	■	0	0
	Operational procedure events																													
	Searching for information	0	0	0	0	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	0	0	0
	Categorising information	0	0	0	0	0	0	0	0	0	0	0	0	0	■	0	■	■	0	0	0	0	0	0	0	■	■	0	0	0
	Programming	0	0	0	0	0	0	0	0	0	0	0	■	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Problem scoping	0	0	0	0	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	0	0
	Checking content/equipment/mcor utensils	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Developing alternative solutions with m/c user interface	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	■	■	0	0	0	0	0	0
	M/C in use	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Impediments to workflow																													
	Interaction Breakdown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	■	■	■	■	■	■	■	■	■	■	■	■	■	0	0
	Interaction Focus-Shift	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	■	0	0	0	0	■	■	■	0	0	0	0	0	0

Figure A.1.12 SL's Traces using the Current Operational Interface (coded at two second intervals)

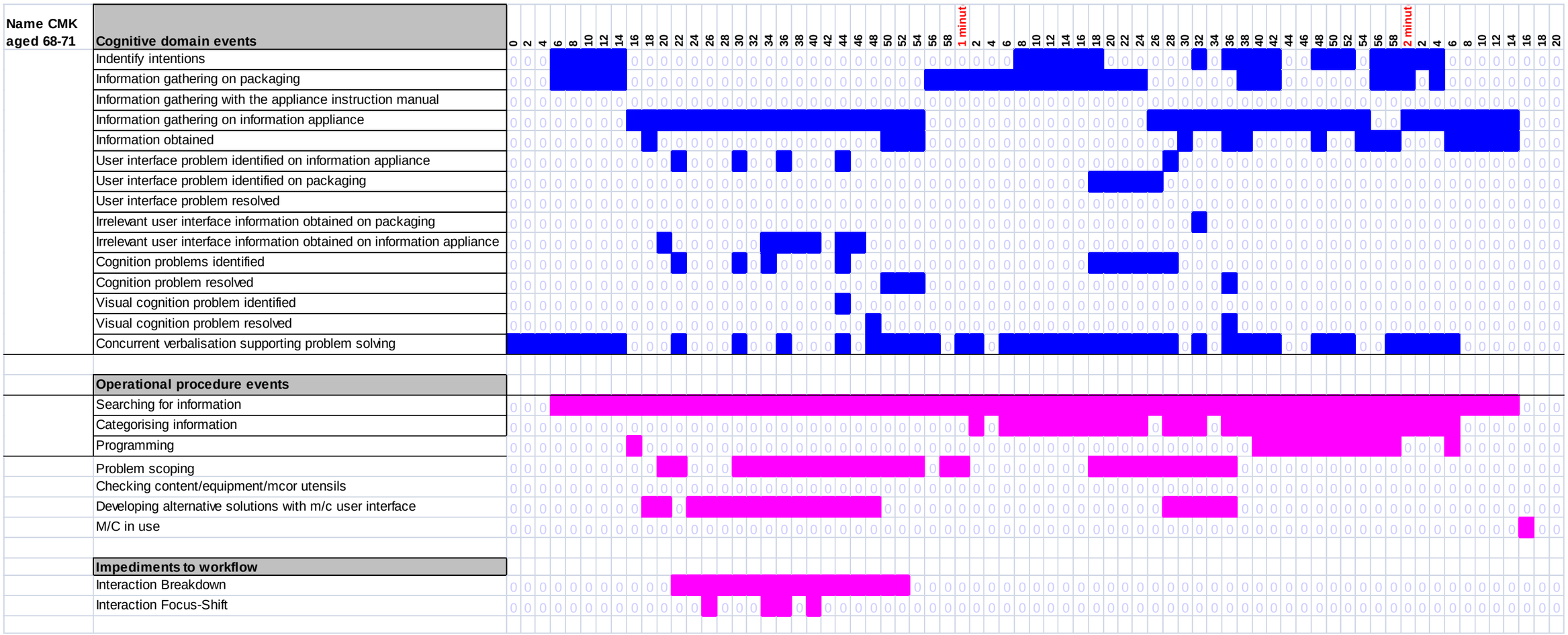


Figure A.1.13 CMK's Traces using the Current Operational Interface (coded at two second intervals)

Name JHaged 70-73	Cognitive domain events	0	2	4	6	8	10
	Indentify intentions	0	0	0	0	0	0
	Information gathering on packaging	0	0	0	0	0	0
	Information gathering with the appliance instruction manual	0	0	0	0	0	0
	Information gathering on information appliance						0
	Information obtained	0	0	0	0	0	0
	User interface problem identified on information appliance	0	0	0			0
	User interface problem identified on packaging	0	0	0	0	0	0
	User interface problem resolved	0	0	0	0	0	0
	Irrelevant user interface information obtained on packaging	0	0	0	0	0	0
	Irrelevant user interface information obtained on information appliance	0	0	0	0	0	0
	Cognition problems identified	0	0	0			0
	Cognition problem resolved	0	0	0	0	0	0
	Visual cognition problem identified	0	0	0	0	0	0
	Visual cognition problem resolved	0	0	0	0	0	0
	Concurrent verbalisation supporting problem solving	0	0				0
	Operational procedure events						
	Searching for information					0	0
	Categorising information	0	0	0	0	0	0
	Programming	0	0	0	0	0	0
	Problem scoping					0	0
	Checking content/equipment/mcor utensils	0	0	0	0	0	0
	Developing alternative solutions with m/c user interface	0	0	0	0	0	0
	M/C in use	0	0	0	0	0	0
	Impediments to workflow						
	Interaction Breakdown						0
	Interaction Focus-Shift	0	0	0	0	0	0

Figure A.1.14 JH's Traces using the Current Operational Interface (coded at two second intervals)

Name JH aged74-76	Cognitive domain events
	Indentify intentions
	Information gathering on packaging
	Information gathering with the appliance instruction manual
	Information gathering on information appliance
	Information obtained
	User interface problem identified on information appliance
	User interface problem identified on packaging
	User interface problem resolved
	Irrelevant user interface information obtained on packaging
	Irrelevant user interface information obtained on information appliance
	Cognition problems identified
	Cognition problem resolved
	Visual cognition problem identified
	Visual cognition problem resolved
	Concurrent verbalisation supporting problem solving
	Operational procedure events
	Searching for information
	Categorising information
	Programming
	Problem scoping
	Checking content/equipment/mcor utensils
	Developing alternative solutions with m/c user interface
	M/C in use
	Impediments to workflow
	Interaction Breakdown
	Interaction Focus-Shift

Figure A.1.15 JH's Traces using the Current Operational Interface (coded at two second intervals)

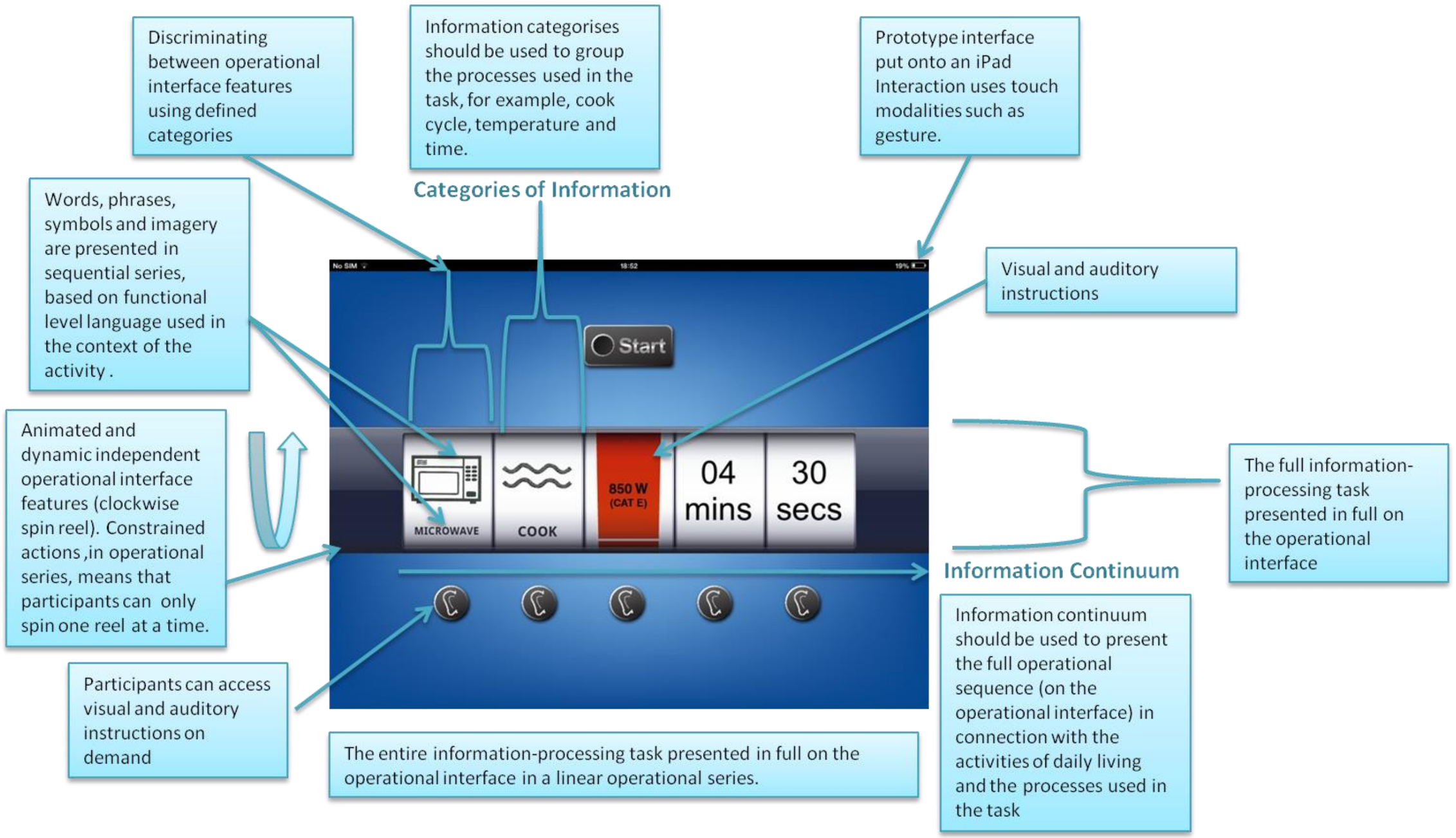


Figure A.1.16 New Operational Interface on iPad App & the Design Goals Summarised ((reproduced from Figure 6.1, annotated with key design features)