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Collection of design data from older and disabled people

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Abstract. If designers are to ‘design for all’, and consider the needs of older and disabled people when designing every day products and environments, data on the physical sizes and capabilities of older and disabled people, as well as able-bodied people, are needed. This paper discusses part of the work of a 3-year project, aimed at redressing some of this balance and providing a computer software tool to assist designers in considering the needs of older and disabled people. This paper briefly describes some of the methods devised and used for the collection of data, and focuses on the ethical considerations of collecting data from older and disabled people, and some of the issues that arose during the data collection.

INTRODUCTION

It is estimated by the World Health Organisation that the world population of people aged 60 years and over will increase from 580million in 1998 to 1000million by 2020 (WHO, 1998). This increasingly older population, together with the disabled population, will affect market forces and impact upon the way that designers consider their end-users (Vanderheiden & Tobias, 2000).

In order for designers to meet the challenge of designing for all, information about the preferences, physical characteristics, and capabilities of older and disabled people is required. However, there is currently very little general data available for these sections of society.

As part of this project, surveys of the information needs of designers with respect to considering ‘design for all’ (Gyi, Porter & Case, 2000), and the design needs of older and disabled people were conducted (Oliver et al, 2001). These were then used to inform the collection of data from older and disabled people, and the development of a computer software tool.

The computer software tool being designed in this project is known as HADRIAN – Human Anthropometric Data Requirements Investigation and Analysis (Marshall et al, 2002). HADRIAN has been developed to complement an existing computer-aided design tool – SAMMIE (Porter et al, 1999). Our particular focus in the project was to provide sufficient information for the designer and HADRIAN to work together in assessing the usability of a given design early on in the design process.

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In order to provide initial data for the computer software tool, it was decided to collect physical and behavioural data from 100 people (75 of whom were older and/or physically disabled). Our approach to the data collection included traditional methods; collecting external anthropometry, joint constraints, and background information on severity of any disability and problems encountered with activities of daily life.

However, the data process also involved capturing more novel data on link lengths, functional reach, postural information and behaviours on a carefully selected set of task elements. The data needed to be sufficient to enable the participants to be represented as individual human-models within HADRIAN, and also to allow investigation of which participants would be able to use a given design and which would be ‘designed out’. This paper will briefly describe the data collection methods, ethical issues, and preliminary findings.

METHODS

In order for the SAMMIE and HADRIAN systems to recreate the individual participants as ‘virtual humans’, accurate anthropometry from the participants was needed. Measurements were taken in postures as close to the standard postures that people could obtain, but without forcing those participants who were unable to obtain the posture. The majority of the measurements taken were traditional external anthropometry, which could then be used with the existing SAMMIE set-up to predict joint centres when constructing the individual participants. External anthropometry is the type most frequently available and collected, yet computer-aided design systems tend to utilise internal link-length measurements. Thus, it was also decided to collect some ‘direct’ measurements of link-length anthropometry, in order to compare these data to external anthropometry and see which gave the most usable information. It was unclear how accurate location of link-length markers would be, given that most of them require some manipulation of joints and rely on ‘invisible’ markers, rather than the bony markers utilised in external anthropometry.

Information from the survey of older and disabled people revealed that many participants wished to be able to achieve Activities of Daily Life (ADL) on their own and maintain independence as long as possible. One such activity that participants wanted to be able to do more fully and easily was use their ovens, with cooking for oneself providing a considerable degree of independence. In order to investigate the tasks involved with using an oven and cooking, a rig was constructed from standard kitchen units, with the work surface, lowest shelf and top shelf reflecting those of a standard kitchen design (see Figure 1).

![Figure 1: The ‘kitchen’ rig, with mock-up oven (centre) and wall-unit shelf](image)
Participants were given a number of tasks to complete, for example, lifting one-handed and two-handed weights (chosen by each participant to be the maximum comfortable load) to the different shelves. These tasks were video-recorded and analysed using a comprehensive postural and behavioural coding scale that was devised as part of this study. The coding was used to identify the different postures adopted, along with any additional coping behaviour, such as leaning on a work-surface for support or kneeling to perform low tasks. The coding of the various postures that a person adopted, as well as any coping mechanisms used in order to complete the tasks, were all vital information for HADRIAN to use in order to assess whether a person could achieve similar tasks in other situations.

Another major part of the data collection was the assessment of reach range. This was achieved by adapting the method put forward by Molenbroek and Steenbekkers (1998). A white board was held horizontally on a pivoting height-adjustable rig, which could be adjusted vertically to the stature of the participant, and then adjusted to 90°, 60°, 30°, 0°, -30° and -60° about the horizontal (see Figure 2). In each position of the board the participant drew an arc with the dominant hand. Photographs were then taken with the board held vertically, and these were then analysed and the co-ordinates of each arc recorded for entry into HADRIAN.

**Figure 2:** Rig for collecting reach range data.

**SAMPLING**

Participants were recruited via posters in two Disability Living Centres, the Loughborough University website noticeboard, from a local day-centre for disabled people, and by word-of-mouth. There were some problems meeting the intended sample range, but of the 100 participants 75 were older and/or physically disabled. Details of the participants, their ages and genders are given in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Number of men</th>
<th>Number of women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older able-bodied (aged 63 years +)</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Older ambulant disabled (aged 63 years +)</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Able-bodied (aged 18-62 years)</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Ambulant disabled (aged 18-62 years)</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Wheelchair users (aged 18 years +)</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>45</strong></td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>

*Table 1: Details of participants age and gender.*
Ability and disability was assessed using an adaptation of the Office of Population Censuses and Surveys (OPCS) method (Martin, Meltzer & Elliott, 1994), resulting in fully able-bodied participants scoring 0, with those with the most minor physical problems scoring 1, and the most severely disabled scoring 10. Details of the spread of disability severity are given in Figure 3.

![Figure 3: The number of participants with each severity score (10 = most severe disability score, adapted from the Martin, Meltzer, & Elliott, 1994).](image)

The data have now all been entered into HADRIAN, and a period of testing will be conducted in order to assess whether the needs of designers have been met, and whether the software can be used to help them consider older and disabled people in the design process.

**DISCUSSION AND SPECIAL CONSIDERATIONS**

The trials required ethical approval from Loughborough University before they could proceed. Due to the innovative nature of the work, a pilot trial was conducted in order to investigate some of the practicalities and issues concerned with the task-based assessments and reach range measurements. It was decided to keep the total length of experimental time to a maximum of one hour, in order to reduce the risk of fatigue and the risk of exacerbation of any conditions amongst the older and disabled participants. Participants were asked after each section of the trials if they felt fit to continue, and were reminded regularly that if they wished to stop they were free to do so.

The room in which the trials took place also required careful consideration, with participant safety and privacy being paramount – curtains and a closing door were essential, as well as the space required for the equipment used. The room also needed to be wheelchair accessible and have an accessible toilet close by for participant use if required.

One of the fundamental aspects of the project was the consideration of ADL, and formed the task-based component of the trials. Participants were asked not to attempt any activities that they would not ordinarily do at home – if it were not an activity they personally would carry out on a daily basis, then they were asked not to attempt it during the trials.

During the lifting tasks to the shelves of the ‘oven’ and ‘kitchen’, participants were not asked to exhibit their maximal lifting strength, but their comfortable maximal. It was felt that it was of no practical interest to know that a person could lift weight X, if in reality they would never attempt that at home but would ask a neighbour or relative to lift it for them.

Two experimenters were present at all times to ensure the safety of both the participant and the experimenter, and to offer any assistance that may have been needed. All experimenters were given training...
in the techniques to be used and the principal experimenter was present for all the trials. Participants were
given full details of the trials and the purpose for them, and signed informed consent forms both to take part
and concerning the use of any photographs and video footage of themselves.

There were some problems encountered during the data collection phase. Volunteers were generally
very willing to take part in the research, but there were some difficulties in finding people to make up the
required sample. It was found that word-of-mouth was one of the most useful recruitment methods,
especially for older participants. Disabled people were harder to locate, with clubs and day centres being the
most useful for non-working people, but these did not access those disabled people who work. Some
participants required transport to and from the trials room, and this took time to organise and the costs of
transportation and participants giving up their time had to be met.

The two rigs that were constructed were very useful, but if the study were conducted with a larger
number of participants then the reach rig would need to be reconstructed to make it easier for the
experimenters to move and alter.

Given the time taken to design the data collection protocol and equipment, to locate participants, and
to carry out the trials, it is easy to see why designers themselves may baulk at the idea of spending such time
and money to obtain such desperately-needed data themselves. The lack of time for involvement of the end
user (particularly at the early stages of design) was a problem highlighted by the majority of the designers
who took part in the survey of their information needs (Gyi, Porter & Case, 2000).

The usefulness and relevance of the data collected within HADRIAN are still undergoing testing but
it has already been shown that this extended data set allows the creation of more accurate virtual humans.
These virtual participants will enable the designer to more easily incorporate the requirements of end users
earlier in designing, guiding and informing the design process.

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