



Strategic Promotion of Ageing Research Capacity

Designing for
Inclusion:
designer-relevant
biomechanical data
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*Meeting the challenges of
an ageing society*

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Designing for Inclusion: designer-relevant biomechanical data

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Many older people struggle with food packaging. This should not come as a surprise: there is little interest amongst designers in meeting older people's needs, or producing designs which would enable a larger proportion of the population to open packaging more easily. This study set out to understand the extent to which designers could use more detailed information about the capabilities of older people as users, through a number of trials with older people. The trials involved observing and recording how older users opened packaging, and a series of interviews with designers about how they approached the design of packaging and the potential of using biomechanical information. "Openability" and designing for inclusion was not viewed as important by the designers, who largely considered that biomechanical information about the capabilities of users was too detailed for their needs. The designers felt that socio-economic information, which is what they currently use, was more important.

Key Findings

- Jars and bottles were found to be the most difficult types of packaging to open. Sometimes opening this packaging resulted in pain and discomfort, even for some of the younger participants. Whilst assistive devices were used, often these did not reduce the difficulty or time taken to open packaging, although they did reduce the discomfort. A variety of opening strategies used by the participants were observed, illustrating both the challenges for users as well as for the designers of food packaging.
- "Openability", a big issue for many people, was not considered a major issue for designers or their clients. They thought that if it was taken into account, it could have an adverse impact on other important design considerations. Also they felt that poor openability was something that would be noticed during field trials and corrected. However, designers rarely consulted older people about their designs, few had any experience of designing for inclusion, and even fewer routinely used ergonomic data.
- In general, data derived from biomechanical tests and observations of users of packaging was viewed with suspicion by designers. They felt it did not reflect real-life, was too situation and product specific, and too precise to be of value to them. However, it was thought that video footage alongside biomechanical data would be valuable. Nevertheless, socio-economic information was considered more valuable by the designers.
- Designers and their clients need training and education in the value of Inclusive Design to society and the role of ergonomic and biomechanical data in avoiding exclusion through design.

The Study

The Issues

Many older people find opening packaging difficult, frustrating and painful. As a consequence, some types of packaging are avoided by this group. This can limit choice of products even to the extent of having an impact on an individual's level of nutrition. Sometimes it leads to additional expense, whilst other packaging simply fails to achieve its intended functions. This is especially true of food packaging, for example milk cartons. Even where packaging has been designed with some 'average' user in mind, its performance is unsatisfactory for many users.

The Background

Biomechanical research is producing valuable data relating to the strength and mobility of users, which could improve packaging design. However, the design requirements of the older generation are frequently not met in the design of everyday products. There are a number of possible reasons for this:

- designers are not always aware that such data exists;
- designers find the data difficult to understand and use;
- data from biomechanical testing does not meet the requirements of designers.

The Aim

The aim of this study was to understand how product designers could access data from biomechanical tests relating to the capabilities of older people when opening packaging.

The Study

The study involved four main activities:

- *A "product designers" view of biomechanical test data.* Practicing designers were interviewed to provide an insight into designers' knowledge of available biomechanical data and how this is integrated into the product design process.
- *How older people open difficult consumer packaging.* This was an observational video study of older people aged between 60 and 90 years, and a control group of younger people, opening "difficult-to-open packaging". They used their preferred method of opening the packaging, with or without assistance of everyday kitchen tools, such as knives and scissors.

- *Biomechanical analysis of the difficulties of opening packaging.* Those involved with the video study are now taking part in biomechanical tests using "instrumented packaging" to enable the measurement of forces and the analysis of force and motion data. This part of the study is still in progress.
- *Guidance on how biomechanical test data should be presented in a meaningful and useable format for product designers.* A second round of structured interviews with packaging designers identified which formats they were most likely to use, together with further developments they would like.

A "Product Designers" View

Structured interviews were conducted with designers in ten companies involved in packaging design, ranging from small consultancies through to large multinationals. The interviews investigated:

- the companies' current design processes and practices, tools and techniques;
- their awareness, understanding, and use of ergonomic, anthropometric and biomechanical data;
- how the needs of older adults are currently considered when designing new packaging;
- which design criteria were important to them and where 'openability' ranked in importance amongst their design criteria;
- their understanding, and use of Inclusive Design;
- the design data they currently use and why.

Findings

'Openability' is not viewed as a major concern, and is not amongst the top three design criteria used by designers. Packaging 'appearance' consistently ranked top.

The designers felt that addressing openability issues could have an adverse effect on other 'important' design criteria, and 'easy to open' packaging was not a specific requirement of the companies or their clients. Ultimately this was a decision for the individual designer. However, designers felt that any difficult-to-open packaging would be something which was noticed early on during user trials.

Packaging designers knew about Inclusive Design, with 90% confidently offering an accurate definition. However, very few had any experience of designing products inclusively and generally they had little knowledge of how to design for inclusion. Whilst some felt they intuitively designed products to be inclusive, there was little tangible evidence of this. One company said they would adopt an Inclusive Design approach if their clients demanded it.

Most of the designers felt they included older adults in their design process through consumer testing or informal discussion.

There was very little evidence of ergonomic data being used; only one of the ten companies regularly used it; not one of those interviewed was encouraged by their management or clients to use such data. Most felt this data was too generic and would rarely be suitable for their specific requirements.

All had an awareness of biomechanics but only one out of ten could offer an accurate definition. Very few knew where they could access biomechanical data.

The preferred approach by the designers interviewed was to design then test products using end users through trials, focus groups, observation and ethnography (for example videoing users for later analysis), but this did not always include older adults. One small design consultancy regularly used an informal group of mainly relatives and friends. A large international manufacturer on one occasion employed a focus group of older people, but this was a 'one off' as they did not consider older people to be in their target market.

Opening Difficult Consumer Packaging.

Forty participants were grouped into four age groups (20-35; 60-70; 70-80; and 80+), which were equally balanced in gender. The participants were studied opening six different types of "difficult to open" packaging:

- Jar (pasta sauce, 440g)
- Soft drinks bottle (500ml)
- Soft drinks can (330ml)
- Tin with ring pull (soup, 400g)
- Child resistant medicine bottle
- Bleach bottle (750ml)

The participants were studied and video recorded opening each type of packaging using the method they would normally use at home. All items were placed on a worktop, and everyday kitchen tools such as knives, scissors and tea towels were made available to be used freely to replicate everyday practice. Participants were also given the option of using an assistive device if they regularly used one in their home.



Laboratory set up for the Observational Video Study (cameras circled)

Each of the items was presented in a random order and participants were asked how they would normally open each type of packaging, for example, sitting or standing, with their bare hands, using a typical kitchen tool or assistive device. They then opened the packaging using their normal approach. Once an item was successfully opened they were asked to rate the difficulty. If they experienced any pain and discomfort during the process they were asked to rate this together with a description, for example sharp, dull, aching, lingering and its location. The video and other data, allowed the most difficult types of packaging to be identified and typical opening strategies and motion patterns characterised.

Within the scope of this project 'Opening Strategy' was defined as consisting of three interrelated key components:

- *Hand Grip Type* - the way the lid of the packaging was grasped such that the participant could apply a torque by rotating their wrist/elbow/shoulder.
- *Starting Posture* - the static position of the wrist, elbow and shoulder joints immediately prior to the application of the force or torque to the packaging.
- *Opening Motion* - the dynamics of each joint as the main opening force or torque was applied to the packaging.

Findings

The two types of packaging which were found to be most challenging for the older participants to open were jars and bottles.

Hand Grip Types: Six common grip types were identified for the bottle. These are shown below with frequency of occurrence also indicated. Lateral Pinch Grip using digits I and II was the most common.



Inverted Power Grip (2/40)



*Lateral Pinch Grip (6/40)
(digits I and III)*



*Lateral Pinch Grip (22/40)
(digits I and II)*



Normal Power Grip (2/40)



*Power Grip (7/40)
(palm & digits III & IV)*



Other (1/40)

For the jar, three main grip types were identified. Unlike the bottle, there was no clear favourite grip with the spherical and box grips being similarly popular.



Cylindrical Grip (1/37)



Spherical Grip (19/37)



Box Grip (17/37)

Starting Posture and Opening Motion: The most common characteristics of the starting posture and opening motions can be summarised for both the jar and bottle as follows:

Jar Start Posture: Left wrist extended, right wrist extended and ulnar deviated, left shoulder internally rotated, right shoulder abducted and internally rotated.

Jar Opening Motion: Left wrist flexion, right wrist radial deviation, right shoulder abduction and internal rotation.

Bottle Start Posture: Left wrist extended, right wrist ulnar deviated, left elbow flexed $<90^\circ$, left shoulder internally rotated, right shoulder abducted and internally rotated.

Bottle Opening Motion: Left wrist flexion, right wrist radial deviation, left shoulder abduction.

Other findings from the video study were:

- Very few participants chose to use assistive devices. When they did, it didn't usually help by making the task any less difficult, or quicker, but it did reduce the amount of pain or discomfort experienced. Those using assistive devices did not seem to have a particularly high level of control.
- No obvious differences between age groups were identified, and the young control group as well as the older groups reported some high levels of difficulty, as well as pain and discomfort.
- Difficulty ratings were generally consistent with previous studies, with jars having the highest difficulty ratings and requiring the highest number of alternative strategies.
- During gripping, subjects were not using their fingers in isolation, they quite often used their palm as well.
- Participants and control group members quite often pressed the packaging down onto the work surface to provide them with extra grip.
- Participants and control group members often used a cup-shaped hand over the top of bottles and jars, grasping 2, 3 or 4 fingers together at once.
- When a subject was right handed they did not necessarily use their right hand to grasp the lid of the packaging and support the base with their left. This was found to be the case for both the younger and older groups.

Presenting biomechanical test data to product designers

Eight companies involved in packaging design participated in interviews to identify the most useful way to present biomechanical data to designers, and to identify other information they might need. These allowed various ways of presenting biomechanical data to be discussed with each of the designers, including:

- video clips of participants interacting with packaging;
- still screenshots/photos of handgrips;
- video outputs showing forces required;
- data relating to pain and discomfort;
- joint angles at the point where the greatest force is exerted;
- resultant moments of force generated at joints;
- accuracy of force/moment application.

The interviews also provided an opportunity to obtain designers' opinions on the various 'novel' approaches of presenting and manipulating biomechanical information within the design process, including:

- virtual biomechanical testing;
- information on which muscle groups are used at different points while interacting with packaging;
- the ability to assess the effects of changing certain design features;
- a database of videos of users with various hand impairments interacting with packaging.

Findings

The prevailing view was that despite the high levels of precision offered by biomechanical testing, there is a strong preference towards traditional video data. There was a belief that any data generated in a laboratory would not reflect real-life. Also, such levels of precision were not needed in the case of packaging design, although they may be applicable to other design projects. This was summed up by one designer: *"Our whole remit as a business is to get [our testing] as real as possible and this feels just like measuring to a high level of accuracy something which is hugely inaccurate"*

While the designers appreciated that any data might help their design, they were cautious of using biomechanical data on its own. They wanted to know more about the person; for example, where they lived, socio-economic

status, what products they used and liked, their previous occupations, who they lived with, their aspirations, and where they shopped.

Another concern about the bio-mechanical data was that it did not lend itself to being gathered systematically or to archiving for reference purposes, because, like much other ergonomic data it tended to be specific and not easily transferred from one project to the next. The time and money needed to set up unique experiments would be prohibitive for the majority of designers and their clients.

Because many designers were not familiar with biomechanics information, it was thought easier to interpret when it had complementary video, either overlaid or playing alongside. More fundamentally, there was a need for some sort of education in biomechanics, sufficient to allow any designer to interpret the data, to understand its significance and how it could be used to improve design.

However, a number felt that they would only want the conclusions from tests, without having to understand what they meant or how they were derived. Access to the raw data in tabular or graph format could be useful once biomechanics knowledge and skill in interpreting results grew. They would also need a clear explanation of how the test was carried out, what variables were controlled and various other details. However the preference was for *video footage*, seen as a richer source of information than biomechanical data, with ethnographic videos preferred over the observational videos.

In conclusion, it appeared that biomechanical testing techniques would not be used as standard on a packaging design project. Many of the designers would use these only if requested specifically by their clients, and obviously they would have to get help to undertake these tests.

The results suggest that the best way to present biomechanical data is with an introduction to biomechanics, clear conclusions from tests, a full explanation of the results and test procedures used, and preferably alongside some synchronised video data. Accompanying this would be information about the end user of a product, giving the designer a more comprehensive view.

Discussion

The trials showed, yet again, the difficulties experienced in opening packaging, especially jars and bottles. These difficulties were not just experienced by older people but also by the younger participants, some of whom experienced pain and discomfort during the trials. There was no marked difference in the way the older and younger groups approached opening the packages, although some older people used assistive devices. In turn, these did not make the task any easier or quicker, but they did reduce the level of discomfort. These findings illustrate the fundamental nature of the problems posed when opening packaging. This is not just a problem for older people.

Yet this fundamental problem of openability was not felt to be an issue by the designers or their clients. Other issues were considered to be more important, and as a consequence the type of information which could be helpful in designing packaging which is easy to open, was ignored.

The designers had little experience in the use of ergonomic data, or the application of the principles of Inclusive Design, although they did know about them. They tended to prefer socio-economic data about their user groups rather than information about the capabilities of these groups. Any difficulty arising from a design was expected to be identified during user trials, although these rarely included older people.

Because most packaging designers are not familiar with biomechanical test data, there is a need for basic education and training in its use. Even so, whilst it appeared that biomechanical data could be used by designers it is unlikely that it could be used in isolation; instead it would need to be supported by ethnographic and observational video studies and combined with information about the user, especially socio-economic data, so as to provide a more holistic view.

Ethnographic videos, for example of individuals opening packaging, are popular with designers as they can provide a rich source of qualitative information, and can lead to more focussed investigation and analysis of the physical opening behaviours.

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The Study

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More information about the study can be found on the SPARC website www.sparc.ac.uk and obtained directly from Dr Thomson.

This project is being continued and extended as part of the postgraduate research work of Bruce Carse. This will lead to the generation of substantial biomechanical data on the difficulties of opening packaging.

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SPARC

SPARC is a unique initiative supported by EPSRC and BBSRC to encourage the greater involvement of researchers in the many issues faced by an ageing population and encountered by older people in their daily lives. SPARC is directed, managed and informed by the broader community of researchers, practitioners, policy makers and older people for the ultimate benefit of older people, their carers and those who provide services to older people.

SPARC pursues three main activities:

Workshops to bring together all stakeholders interested in improving the quality of life and independence of older people.

Advocacy of the challenges faced by older people and an ageing population and of the contribution of research to improving quality of life. SPARC is inclusive and warmly welcomes the involvement of everyone with a relevant interest.

Small Awards to newcomers to ageing research, across all areas of design, engineering and biology and at the interfaces relevant to an ageing population and older people. In 2005 and 2006 SPARC received 185 applications for support in response to two invitations for competitive proposals of which 34 were supported.

Executive Summaries

SPARC is supporting its award holders through funding, mentoring, a prestigious dissemination platform, professional editorial assistance, international activities and provision of contacts. Each of the projects has been small, yet the enthusiasm for discovery, and impatience to contribute to better quality of life for older people, has more than compensated for the very limited funding which was provided.

This executive summary is one of a series highlighting the main findings from a SPARC project. It is designed to stand-alone, although taken with summaries of other projects it contributes to a formidable combination of new knowledge and commitment by newcomers to ageing research, with a view to improve the lives of older people. This is a tangible contribution towards ensuring that older people receive full benefit from the best that research, science and technology can offer.