Strategic Promotion of Ageing Research Capacity

Making Jam Jars Easier to Open: the inclusive engineering approach

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Meeting the challenges of an ageing society

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Making Jam Jars Easier To Open:
the inclusive engineering approach

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For many older people, independent living can be compromised by difficulties in opening food packaging. The jam jar is often a source of difficulty, but it doesn't need to be. Surprisingly little research has been done to investigate the ability of people to open jars. Using a new device for gathering data, the abilities of over 1000 people to open jars were measured. Despite variations relating to age and gender, it was possible to select a simple design standard which would enable 97% of the population to open all jars between 55mm and 85mm in diameter without needing to resort to kitchen aids.

Key Findings

- The study produced one of the largest data sets of its kind on the strength required to open off-the-shelf jars commonly found in shops.
- Few age ranges had problems with opening jars with lids of 55mm diameter (typically used for chutney and small jam jars). However, half of the women over 75 did have difficulties, and would have been unable to open half of the jars of this size available in shops.
- Most of those tested had difficulties with the strength required to open lids of 85mm (typically used for full metric sized jam jars) and would have had to resort to using opening aids.
- For men aged between 30 and 60, average torque strength (used when twisting or turning a jar lid or bottle cap) rose with increasing diameter of lid, but this was found to decline for men aged over 60.
- For women aged between 30 and 60, average torque strength was fairly level across the diameters, but for women aged over 60 it was much lower and declined with increasing diameter.
- A reasonable design standard would be for a limit of 1Nm to open any size of jar. With this limit, 97% of the population could open a jar between 55mm and 85mm. However, achievement of this standard would have implications for the design of larger jars.

Introduction

The Issues

Hands are used for many things, from the tiniest and most dexterous of tasks to heavy manual labour. Nearly all actions using the hand require some form of grip, but as people age there is a massive decline in strength and dexterity. These natural decreases, combined with debilitating illnesses such as arthritis, mean that hand grip strength and finger grip strength can be seriously affected in older people. This makes it much harder to twist, pinch and pull objects. There is often a marked decrease in torque (turning and twisting) strength which occurs with age, and this is caused not so much by a decrease in wrist strength, but by a decrease in grip strength.

The Background

Although a lot of data exists about strength, it is largely generic and illustrates trends in the population. It is therefore not accurate enough to indicate specific limits when designing products. For example, data about grip strength is usually measured on two parallel bars and does not accurately represent the kind of grip used to open most kinds of packaging. Data about the torque applied when opening a jar has been measured, but the apparatus used was an aluminium jar with a brass lid attached and a torque gauge inside; the majority of jars are glass with aluminium lids. The differences of friction between skin and glass, as opposed to aluminium and brass, results in different forces being applied and required. This does not therefore accurately mimic the process of opening a jar.

In order to make a jar of jam accessible to the weakest target consumer, it is necessary to know the forces that the weakest target consumer can apply to the jar of jam itself and not to an aluminium jar with a brass lid.

The Aims of the Study

The principal aim of this study was to measure torque strength and grip strength, of people of all ages and physical abilities, using an improved measuring technique which accurately resembled a jar of jam.

The Study

Previous work by the Engineered Packaging Group at the University of Sheffield has improved on earlier data collection methods. An average sized glass jar was taken and the top cut off, then a torque gauge was inserted and the lid used with the jar was attached to the top. Weight was added to the inside to match the feel of a full jar; individuals could then handle and open the jar as they would normally. This device was used to measure the strength of individuals of different ages, in the few actions that are used to open a jar. Major improvements were also made to the data collection equipment to which the device was connected during the course of the study reported here.

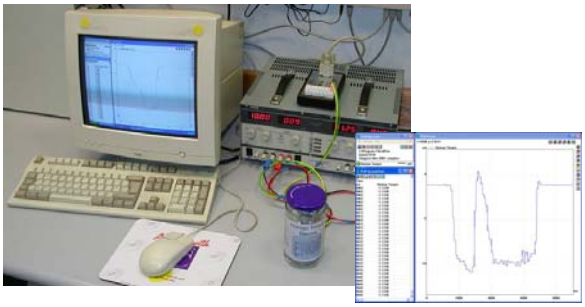
Engineered Packaging Human Torque Measuring Device

1142 individuals, aged from 8 to 95, took part in the study which involved assessments of the strength required to open off-the-shelf jars commonly found in shops. Three sizes were considered, 55mm, 75mm and 85mm. The study has produced one of the largest data sets of its kind

The data was used to find the person in the sample group with the lowest maximum opening strength. This enabled design limits to be identified. These design limits could be used to set targets for the maximum sealing forces of packaging, so that even the weakest target consumer would not be overcome.

The Equipment

The original device, connected to a sampler, power supply and PC to capture the data, required measurements to be made individually and the data processed by hand (see below).



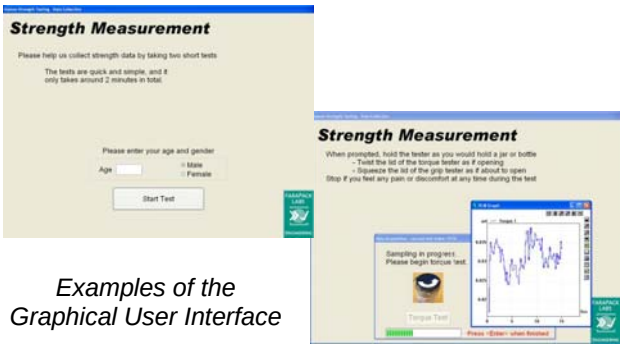
Initial set up of torque measuring equipment and typical output

In order to gather and process a large number of tests, a new device was built (see below). This new device was capable of handling and analysing data automatically, and was portable and more user-friendly. It was also easily modified to handle different size jars.

Portable test equipment

In addition to the new device, it was necessary to develop a simple-to-use graphical user interface in order to speed up data collection and to facilitate analysis. This shielded the user from the complexity of the computer programme used to collect and analyse the data whilst still offering all the required functionality. It ensured that the correct method for sampling data was followed; that no data was lost or overwritten; and also collected information about the age and gender of the participants at the time of their tests.

This approach enabled the data values to be stored in a format which made the data analysis easier, minimising the time taken for later processing. Modifications also enabled graphs of user strength against either age or jar lid diameter to be displayed in real time, to show that the test has been performed correctly.



Examples of the Graphical User Interface

The Tests

Each participant was tested individually, and asked to twist the lid of the test device in the same manner as they would normally open a jar. In order to ensure that they put in maximum effort, they were not told that the jar lid would not open. Participants chose whether to stand or sit for the test, and could pick up the jar or leave it resting on the table. No type of grip was suggested, and multiple attempts using different postures or grips were allowed.

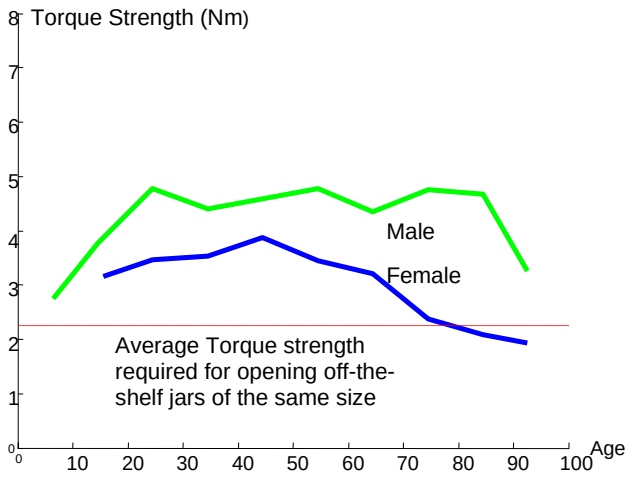
Participants were encouraged to make sure they applied the highest torque strength that they could, but were instructed to stop if they felt any pain or discomfort during the test. This encouragement ensured that the participant put in maximum effort for the test, mimicking their desire to access the contents of the jar.

The maximum applied torque in the anticlockwise direction was calculated for each test done, then after the test, the participant was shown the computer output. If they felt they had not used their maximum torque strength, they were given the option of repeating the test. The maximum torque applied by each participant was then calculated and recorded together with their age and gender.

Findings

Torque Strength

The average torque strength across the age ranges studied is shown below. In these graphs, the green band represents the average torque strength range for the male participants, whilst the blue band represents the average torque strength range for the female participants. The red line represents the average torque strength that was found to be needed to open off-the-shelf jars of the same size.



Torque by age for a 55mm diameter jar

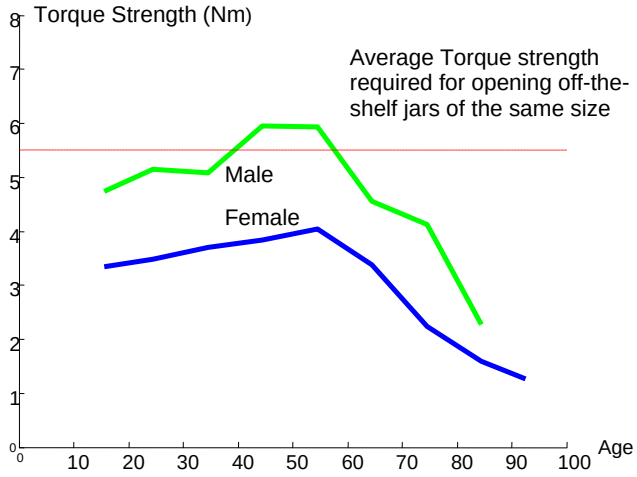
The test results from 509 participants (285 male and 224 female) showed that few people have problems opening a jar lid of 55mm. For most ages of participants, the average range of torque strength is well above that needed to open the average jar. The data suggests that younger children may have difficulty opening jars of this size, but this is not really an issue as there is little need for children of this age to perform such tasks. Another group which may have problems with opening jars with lids of 55mm diameter are older females, and this is more of a concern. Over 50% women aged over 75 would have been unable to open more than half of the jars available in shops.

Although the data suggests that older males would not have had any problems with this task, torque strength by the oldest males dropped sharply with age. It was therefore thought likely that any subjects above the age of 95 would struggle to apply the required forces to open jars with lids of 55mm diameter.

The test results from 274 participants (150 males and 124 females) are shown for the 85mm jar lid in the graph below. Most of those tested would have struggled to open most jars.

Males between the age of 40 and 55 were the only group likely to be able to open more than half of the jars on the shelf. Younger and older males were on average weaker, and therefore less likely to be able to open jars of this size. Almost all men of age 55 and older would have been unable to open jars of this size, since torque strength was found to have dropped sharply at this age.

The results suggest that very few of the female subjects, of any age, would have the torque strength required to open jars found on the shelf with a lid of 85mm. It is interesting to note however, that although the female subjects were weaker than their male counterparts across most ages, the gap between the two sexes became smaller with age. The males lost their torque strength faster with age compared to the female group.



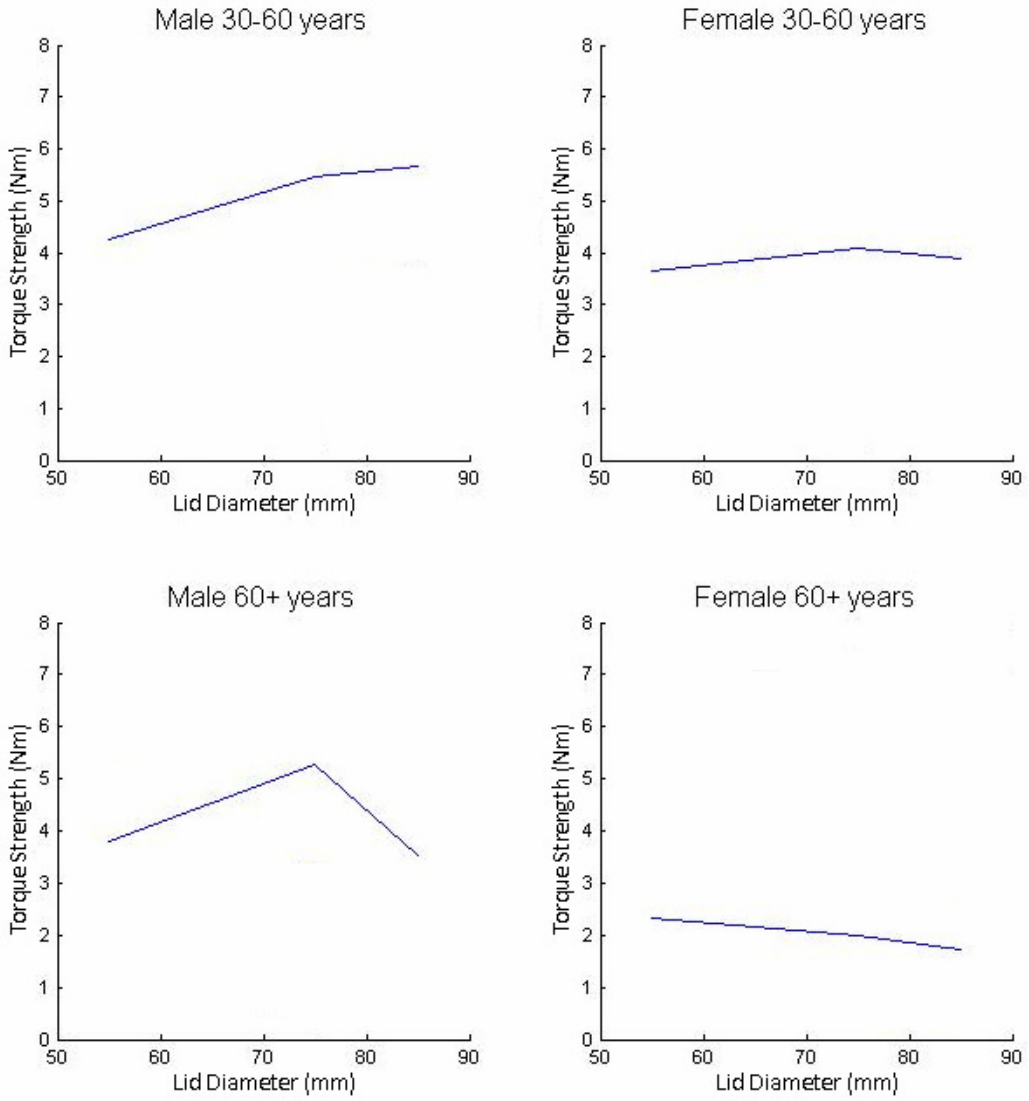
Torque by age for 85mm jar

These results were supported by comments made by participants of both genders during testing. Many people mentioned that they were often unable to open larger jars unaided, and had to resort to various opening aids. The oldest subjects often indicated that they would not buy products in such large jars as they knew that they would be unable to open them.

The Effect of Diameter on Torque

To investigate the effects of diameter on torque, data from 908 tests was analysed. To minimise the effects of ageing on the results, the age groups were split for the test with younger and older groups created for each gender. The younger group contained participants aged 30-60 years old; the older group was made up of participants aged over 60. These age groups were chosen after examining the Torque-Age graphs (see previous page) from which it was found that measured ability evened out between 30 and 60, with lower recorded values either side of the band.

Lid diameter has a pronounced effect on the amount of torque strength that male users apply (see below). Younger males continued to apply higher torque strengths as the diameter increased (within the diameter limits tested). In contrast to this, the older males applied far lower torque strength when trying to open the larger lids. This means that, although younger men may not have struggled to open larger jars, progressively older groups had problems. The younger females applied higher torque strengths than the older group for the entire diameter range. However for both young and older females, the levels of torque were fairly similar across all diameters of jars.



Average torque strength required to open a range of lid diameters for each age group.

Discussion and Implications

The strength and forces that people are able to apply to a task are dependent on many factors and can be influenced by age and physical condition. As age increases past 60, strength begins to reduce rapidly. The force that can be applied to packaging is also very dependent on the nature of the packaging itself. Even seemingly small changes in materials or shape can have a large impact on the forces an individual is able to generate. Specific testing is therefore required to determine the forces that a consumer will be able to apply to a particular package.

When the strength of the weakest individual within a target group has been established, design limits based on the strength of that weakest user can be set. If these design limits are then adhered to, all individuals within the target group should be able to open the packaging. In the case of food packaging such as jars, the target group should encompass as much of the population as possible and be designed with the weakest consumers in mind. The current opening torque strength requirements for jars mean that many users are unable to open them. This is especially the case for opening larger jars, where tools are frequently required to aid this activity. This is unacceptable.

Judging from the test data, a reasonable design standard would be to set a limit of 1Nm torque to open a medium size jar. This should enable approximately 97% of the population to be able to open food packaged in jars. For the larger sizes of jar, this may challenge manufacturing processes. However, this could be overcome by either packing foods in smaller quantities or through creating new designs of jar of the same volume but with smaller closures.

Getting to grips with a jam jar

A user group

The Research Team

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The Study

The study received financial support from SPARC of £18,548 and ran for 6 months ending in July 2006. Additional support was provided by the University of Sheffield.

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

Bibliography and Key References

The project has led to the direct publication of the following peer reviewed journal papers.

Yoxall A., Langley J., Luxmoore J., Janson R., Taylor J.C., Rowson J. 2008. Help or Hindrance: The Use of Tools for Opening Packaging. *Designing Inclusive Futures*. 65-74

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Yoxall A., Janson R., Bradbury S. R., Langley J., Wearn J., Hayes S. 2006. Openability: Producing Design Limits for Consumer Packaging. *Packaging Technology and Science*. **19**: 219-225

The study has also been presented at numerous conferences including "The Universal Package", Michigan State University, USA, 2006, and "The Cambridge Workshop on Universal Access and Assistive Technology (CWUATT)", 2008, Cambridge University, UK.

Acknowledgements

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Disclaimer

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.