



# SIZING UP AUSTRALIA

## - THE NEXT STEP

### Chapter 1: Report Summary

Defining the method and scientific parameters for the Australian Body Sizing Survey

This report was commissioned by Safe Work Australia.

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## Executive Summary

Safe Work Australia is a national policy setting body whose key role is to improve work health and safety and workers' compensation arrangements across Australia. One of the key action areas of Safe Work Australia's, *Australian Work Health and Safety Strategy 2012 – 2022* is to promote the role of safe design in eliminating and minimising risks to work health and safety. Another is to promote research and evaluation.

This research project builds on work commissioned by the ASCC, now Safe Work Australia, in the 2009 report, *Sizing Up Australia – How Contemporary is the Anthropometric Data Australian Designers Use?* *Sizing Up Australia* (Veitch, Caple et al. 2009) noted that there was an increasing regulatory requirement for designers to consider the work health and safety implications of their designs; indeed these requirements have since become reality with newly harmonised work health and safety legislation in Australia. It identified that in order to design with work health and safety as a design parameter, appropriate tools and data are required by designers. However, whilst there is a regulatory thrust to embed work health and safety into the design process, designers do not have available to them key data about the population for which they are designing. Anthropometric data of the working population and the tools that enable their use are necessary to the process of safe design of the physical environment. They are not, however, sufficient for safe design. Making anthropometry more available will not automatically result in safe design because other imperatives, such as cost and business strategy, are also part of the design process. But *not* having it will mean that safe design is less possible to achieve, even if there is a strong desire to achieve it.

*Sizing Up Australia* took a design engineering perspective and clearly demonstrated the gap and the need for high quality Australian anthropometric data. This gap can only be filled by a well-constructed and well-executed anthropometric measurement survey of a representative sample of Australian people. *Sizing up Australia* did not define the method and scientific parameters for such a survey, but this step is critical to producing a high quality sizing survey that meets the needs of stakeholders. This research project aims to define the best way to fill the gap by establishing the method and defining the scientific parameters for the conduct of an Australian Body Sizing Survey to ensure that it achieves a high quality, useful dataset that is developed as a national resource that would be accessible by all. This project is Step 2 in the process illustrated in Figure 1:

|  |   |   |  |
|--|---|---|--|
| <b>STEP 1</b><br><b><i>Sizing up Australia</i></b><br>Demonstrated the need for an anthropometric survey | <b>STEP 2</b><br><b>This project</b><br>Determine the method and minimum scientific parameters for the Australian Body Sizing Survey. | <b>STEP 3</b><br><b>Next project</b><br>Identify stakeholders, test parameters against their needs and address their concerns. Finalise method and scientific parameters. | <b>STEP 4</b><br><b>Final step</b><br>Conduct the Australian Body Sizing Survey by collecting raw data according to the agreed method and scientific parameters. |
|--|---|---|--|

Figure 1: Where this project fits in the planning for an Australian Body Sizing Survey

The report is presented in three sections. **Chapter 2** is a comprehensive review of international and Australian academic and 'grey' literature about national sizing surveys and international standards in other leading countries, with particular reference to those surveys undertaken with work health and safety objectives in mind. This literature review builds on the work reviewed in *Sizing Up Australia*. **Chapter 3** defined the scope of the

Australian Body Sizing Survey. It addressed the key features of stakeholder engagement and how this would determine the range and type of measurements to be obtained. It also described the systems engineering model that would be used to develop the testing required to finalise the survey method, business plan and costing. It outlined possible sizing survey methods and recommended sampling method, recruitment strategy and data management. **Chapter 1**, this report, summarises the whole report including factors influencing the budget and resources.

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# 1. Key project findings

## 1.1 Key findings

In summary the key findings are:

1. A good database with 1-D and 3-D data that represents the relevant user population and that is used in the right way enables two important things. Firstly, it enables risks to health and safety from design-related faults to be eliminated or minimised resulting in safer design for new products and environments. Secondly, it enables knowledge-based evaluation and the identification of the risks posed by existing designs of environments, furniture and equipment. This means that priorities for improvement in design, or the avoidance of features of a design, can be applied to groups of people or segments of the population by taking their particular body size and shape into consideration.
2. From the recent Safe Work Australia report on the costs of work related injuries (NOHSC 2004, Driscoll, Harrison et al. 2005, Safe Work Australia 2012) it is clear that there is a large economic and social cost experienced by the nation for work injuries that are the outcome of poor design. The Australian Body Sizing Survey could assist in reducing this economic and social burden for a relatively minimal cost.
3. Australian Body sizing data that is delivered from the survey should be readily accessible to the public and not be locked away or shielded from general use. Accordingly, the Australian Body Sizing Survey should be conducted as a public infrastructure project.
4. Many other countries including Korea, USA and The Netherlands have Sizing Surveys of their populations that enable not only safer and more effective design, but also assessment of workspaces for health and safety. Australia, with its unique population, also needs a Sizing Survey if it is to achieve these objectives. A Sizing Survey in the form of a publically owned, national infrastructure resource would mean that designers and manufactures of products for the Australian market could freely access the survey to create safe designs for our population.
5. The capacity to design and deliver the Australian Body Sizing Survey would create an edge for Australia as a leader in our region on several different levels: in how to conduct a stakeholder-led Sizing Survey; in managing the Survey data; in developing the tools necessary to enable the data to be used by designers; and finally in safe design itself.
6. Stakeholder engagement is essential to the Australian Body Sizing Survey. It would allow the Survey parameters to be developed and tested against stakeholders' needs so that any concerns and specific needs could be addressed in the design and testing-stage of the Survey. This critical step would result in an Australian Body Sizing Survey that meets the needs of those who would use the data, increasing the likelihood that the data will be used to produce safe designs. The scientific parameters, method and budget cannot be finalised without this.
7. A systems engineering design process needs to be applied to the development of the final survey method, which includes iterative planning, rehearsal and pilot testing of all the processes, hardware and software. This will take time and resources.
8. International standards that describe aspects of gathering anthropometric data are not sufficient. They need to be partnered with the experience and expertise of experts who have undertaken previous surveys that have proved useful in engineering and design applications. Their successes and potential improvements need to be understood to capitalize on their accomplishments while avoiding potential traps and pitfalls.
9. 3-D and 1-D data have different uses, strength and weaknesses. Both are essential for maximum usefulness of the Australian Body Sizing Survey.

10. It may be that some 1-D measurements can be reliably and accurately collected from 3-D scans, but determining this requires testing and validation. 1-D measurements that prove to be unreliable and inaccurate when extracted from 3-D scans need to be collected in the traditional way. The traditional way of collecting 1-D data is reliable and accurate.
11. Fit and accommodation information are essential to characterise the relationship between models and the environment.
12. Recent developments in 3-D scanning technology, where the time for image acquisition is very fast, offer the possibility of rapidly acquiring high quality additional scans in sequence (possibly 30fps – frames per second) to characterize movement including reach/accommodation information in a very cost efficient way. This would increase the usefulness of the database to workplace applications.
13. An International Technical Committee, consisting of technical experts, would be established to guide the stakeholder engagement and survey processes, provide technical input and act as an arbiter when technical decisions are being made.

## 1.2 Value

The value proposition for the Australian Body Sizing Survey is compelling. The data from the survey would contribute to the well-being and welfare not only of working women and men, but also to the broader community. In this report we have put the focus on design for the workplace and the impact of the survey on work health and safety. We assert that the Australian Body Sizing Survey will contribute to at least three of Safe Work Australia's Action Areas: healthy and safe by design, supply chains and networks, and health and safety capabilities (Safe Work Australia 2012). The impact will flow from the development of Australian body size information, in combination with the adoption of new methods of using these data, to influence the physical design of workplace environments and equipment. Investment in this approach can help to get designs right the first time to avoid dangers inherent in poor design, the costs of reducing mismatches, and the need to retrofit or refurbish.

The Australian Body Sizing Survey may also have indirect influence on Safe Work Australia's other Action Areas by influencing the way we think about the relationship between design and work health and safety. As the Australian population changes by, for example, extending the working age or due to increasing obesity, the variation in the population is going to increase and existing design and accommodation problems become worse. A focus on measuring the Australian population and the resulting dataset should support the growing impetus for the "safety by design" approach and the increasing regulatory requirements for designers, manufacturers and suppliers to demonstrate how they are achieving safe design of plant in workplaces to reduce risks of death and injury.

A systematic approach based on knowledge, such as the anthropometry of the user population and their functional capacity mapped against functional requirements, will not only assist in solving current problems, but also form a scientific base upon which to predict future requirements.

While this project has focussed on the impact of the Australian Body Sizing Survey on workplace health and safety, the value prospect for this survey inherently extends well beyond this realm. Additional beneficiaries would include public health, defence and apparel designers and manufacturers and it is likely that this list of possible stakeholders will grow once the process of stakeholder engagement commences and matures.

## 1.3 Impact of design issues on work-related injuries in Australia

Work-related fatalities and total and permanent disablement (defined as "serious injury") are the extreme outcomes of poor workplace design. In the last ten years investigations have

revealed that work-related death definitely or probably stemmed from poor design. The 1997-2002 study of the causes of work-related deaths suggest that approximately 37% “definitely or probably had design-related issues involved” (NOHSC 2004) and that design issues were involved in possibly 50.5% of work-related fatal injuries and at least 30% of serious work-related injuries involving:

- all machinery and mainly fixed plant
- self-propelled plant, semi-portable plant and other mobile plant
- all powered equipment, tools and appliances
- ladders, mobile ramps and stairways and scaffolding

Inadequate fit or the absence of barrier protection across the expected range of use of the item was found to be the main source of risk and ultimately the cause of death in these injuries and fatalities (Driscoll, Harrison et al. 2005). The use of anthropometric data, through a fit-mapping process across all anticipated aspects of use of these items of plant may have resulted in a higher focus on user-centred design, less hazardous design, and ultimately a reduction in these serious injuries.

More recently, Safe Work Australia (Safe Work Australia 2012) has estimated the total cost of Australian work related injuries to be \$60.6 billion for 2008-09.

An attempt to attribute the cost impact of these fatality and injury rates from poor design in this report has not been made because of the complexity. However, at these estimated outcome levels the personal, financial, social and organisational impacts are likely to be high and warrant new strategies for design based improvements to reduce these levels of death and serious injury. It is very likely that the annual costs would well out-strip the cost of developing and maintaining the Australian Body Sizing Survey.

## 1.4 Purpose and stakeholder engagement

The purpose of the Australian Body Sizing Survey is to obtain representative body size data for the Australian population so that a wide range of stakeholders can use this to improve what they do for, or supply to, Australians. We regard stakeholder engagement in the project as a critical foundation for success, so we have outlined processes that will enable the systematic identification and involvement of stakeholders from the outset. Stakeholders would not only assist with funding the survey; they would also help to shape the survey and the selection of measurements included in it. As a result they would derive considerable benefit from their engagement while simultaneously demonstrating the benefit for others that will lead to the use of the Australian Body Sizing Survey to improve design for all Australians.

## 1.5 Funding the sizing survey

A useful Australian Body Sizing Survey will have significant costs associated with it. We propose three user-pays funding models to initiate thinking about how the necessary finance to support the survey might be raised. They combine the allocation of a set number of measurements that would be determined by general consensus between all stakeholders, regardless of their level of funding contribution, with a second and larger allocation of measurements that survey sponsors can determine. The number of measures that a funding stakeholder could determine would be directly proportional to their level of contribution. The models differ in the number of agreed measures and the number of measures available for negotiation. Both funding models allow for in-kind sponsor support such as use of facilities, manufacture of scanning garments or the provision of inducements and incentives for subjects.

At the outset of the project we propose that only two measures be regarded as non-negotiable: standing height (stature) and weight. All other measures would be open to

negotiation with stakeholders. It is likely however that a theme of common measures will be identified within this process. These may be consistent with some of the measures obtained in previous surveys and reflect common postures adopted by people as they interact with and operate within physical environments. International experience dictates that careful consideration, planning and organisation are required to not only run the survey to obtain the required measures but to deliver the data in a useful and usable format in the most cost efficient way.

Any contributor of funds to the Australian Body Sizing Survey will be seeking value for money. We have addressed this need in several ways in this report. We have considered the value proposition for stakeholder engagement, identified the trade-off between utility and cost, and considered where value for money lies in the selection of a scanner to do the work. We propose that spending on this project will deliver best value for money when a medium to high level of expenditure is made on the components of the project. That is, on the one hand, a low cost approach will be incapable of delivering results that are useable for design purposes, effectively defeating the purpose of the exercise. On the other hand, high cost in all components of the project is not necessary to achieve the desired outcomes.

We weave the path through this maze by providing the information necessary to determine where to place the highest expenditure in order to gain the best outcomes. However, the option where government funds a well resourced survey and other stakeholders fund the applications, tools and fitmapping to use this data has been identified as the preferred funding approach for the Australian Body Sizing Survey. This should ensure that it is conducted as a public infrastructure project.

## 1.6 International Technical Committee

Whilst stakeholder engagement is critical to the Australian Body Sizing Survey, the complexity and technical nature of the project cannot be denied. In order to establish clear and transparent processes for the development of the technical scope of the project, the selection of measurements, the investigation into the most appropriate landmarks and scanning options would need to be informed by subject-matter experts. Thus, we propose that an International Technical Committee, consisting of technical experts, would be established to provide technical input and act as an arbiter when technical decisions are being made. The project would need to assemble a multi-disciplinary team at the outset and adopt this approach for the planning and coordination of resources and logistics. Risk and quality management systems would also be applied to establish effective management systems and methods to run the Australian Body Sizing Survey project.

## 1.7 Systems engineering approach

This complex project would require a multitude of iterative steps: ongoing stakeholder consultation, determination of the measures to be obtained, review and selection of a whole body scanning device, testing of the method and equipment, recruitment and training of a project team, running an initial trial or pilot survey, subject recruitment, delivery of the main survey and the processing and management of the data. We propose that this systems engineering approach is used to manage this project and the interactions between these components.

## 1.8 Using cutting edge technology

Australia is well placed in the timing of the Australian Body Sizing Survey to take advantage of cutting edge scanner technologies. We are concerned that the best value for money in the selection of a scanner is an important part of the establishment of the project, so we provide some basic information about the range of scanners currently available and include

information about leading edge technologies. All potential technology should be assessed prior to purchase against a criteria for producing a “good” measurement. Any technologies that produce the required quality should be considered. Technology that potentially allow for the collection of dynamic range data for the first time should also be included as these data would be of particular value in the work health and safety arena, especially if combined with biomechanical data. A large-scale Australian Body Sizing Survey using these parameters would create the next gold standard for an anthropometric survey with concomitant competitive advantage for stakeholders.

## 1.9 Subject selection and participation

In discussing the issues of subject selection and participation we incorporate the ethical requirements that accompany involvement of subjects in a project like this. We discuss the importance of retaining high quality control on the data and effective data management for the long term.

We consider the complexities of estimating sample size and propose a method based on a process of sampling that minimises bias and is based upon error estimates from past studies. We outline that the number of measurements/demographic and fit variables that can be included will be contingent upon the reasonable time we can expect a subject to participate combined with the resources available to measure. Resources will include the scanner selected, the 1-D measurements and method of collection and the data collection team(s) size. We outline a process for selecting (down-selecting) measurements / poses landmarks once the stakeholders are on-board via the International Technical Committee. The budget and resources needed will flow from the outcome of the decisions that inform the method and scientific parameters for the Australian Body Sizing Survey.

We also consider the importance of comparability of data, particularly in making the output of the Australian Body Sizing Survey available to designers through the existing online portal, WEAR (World Engineering Anthropometry Resource).

## 1.10 Opportunities

The Australian Body Sizing Survey potentially opens new opportunities for Australian designers, data analysts, tool developers, manufacturers and other stakeholders in this important project. Given that once established, the Australian Body Sizing Survey will need to be maintained and used over successive generations, this initial planning phase has critical implications well into the future. It has the capacity to place Australia at the leading edge in these fields providing new opportunities as well as contributing to healthier and safer workplaces.

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