

SIZE



BEIJING
Capital of the People's Republic of China
Population: 11.29 million
Scanning dates: 8/24/06-9/4/06
No. of valid data: 342

SHENYANG
Capital of Liaoning Province
Population: 5.0 million
Scanning dates: 3/16/06-5/25/06
No. of valid data: 320

CHONGQING
Edge of Yungui Plateau
Population: 10.39 million
Scanning dates: 11/5/05-5/14/06
No. of valid data: 373

SHANGHAI
Capital of Shanghai Province
Population: 8.25 million
Scanning dates: 5/23/06-5/26/06
No. of valid data: 370

LANZHOU
Capital of Gansu Province
Population: 2.94 million
Scanning dates: 6/26/06-7/5/06
No. of valid data: 371

HANGZHOU
Capital of Zhejiang Province
Population: 4.15 million
Scanning dates: 6/5/06-6/7/06
No. of valid data: 364



The world's first digital database of Asian head and face shapes could help change the way all industrial designers think about ergonomics and fit.



In January 1998, Vermont-based snowboard manufacturer Burton held a meeting to find out why one of its award-winning products, a helmet, had sold well in the United States and Europe but miserably in Japan, the world's third-largest snowboarding market. In attendance was a group of Japanese snowboarders, and Roger Ball, whose Toronto firm, Paradox Design, had designed the helmet. The answer from the snowboarders had nothing to do with colors or styling, he remembers. "They said, 'We can't wear it—it gives us a splitting headache,'" Ball says. "I asked why and they said, 'We have a different-shaped head than you.'"

Ball has since made Asian head shapes the focus of his career. With Burton's encouragement, he began designing a helmet specifically for the Japanese market, but shelved the project after he failed to find anthropometric data specific to Asian people. In 2004 he returned to the problem as a newly appointed assistant professor of design at the Hong Kong Polytechnic University, where it seemed a fitting subject for academic research. After securing a government grant, three industry sponsors, six partner universities, and an expert team, he



Cities

by PETER HALL

To build an anthropometric database of head shapes, the Size China team drove trucks of bulky 3-D scanning equipment to six different locations in mainland China, where researchers at partner universities had secured locations and recruited volunteers representing a sample range of age and

gender variations. Project director Roger Ball claims that the recruitment was easy. Ill-fitting helmets and bird-flu-resistant face masks are commonplace in China. Documentation of the process, by photographer Ki Wong, provides a compelling portrait of a country's population amid an industrial revolution.

Photos: Ki Wong/Courtesy Size China; population data: courtesy the China Data Center of the University of Michigan

DATA



★ Research

Above, a male subject in front of a Cyberware 3-D scanner in Lanzhou. Volunteers wore elastic wig caps because even sophisticated scanners have trouble scanning complex reflective surfaces such as shiny hair.

began an epic, if fast-paced, field study, taking a truckload of high-end 3-D scanning equipment around six provinces in mainland China to scan 2,000 Chinese civilians.

This year Ball will publish the world's first digital database of Chinese head and face shapes, labeled Size China. Amid the frenetic pace of industrialization in China, the data could have a dramatic impact on the design of helmets, caps, sunglasses, face masks, and other protective headgear for Asian markets; as part of a set of new 3-D reference tools that organize body types according to shape variations, it may also play a part in changing the way designers around the world think about sizing.

Ball, who is 50 and speaks in a cigarette-inspired bass register reminiscent of Leonard Cohen's, discovered what he calls the "revitalizing" effects of anthropometric research after becoming disenchanted with product-design consultancy work. "I'd made millions and millions of dollars for other people," he says, citing the nine million kids' bike helmets that Fisher Price have sold from his design. When Burton announced that it had hired an in-house CAD engineer to take over the design development of Ball's helmet concepts, he says, "I knew my business model



Facilitators used a range of procedures for gathering data, from the traditional to the high-tech. More than 2,000 volunteers between the ages of 18 and 70 were scanned; each watched an orientation video, filled out a questionnaire on age, gender, and family origins, and then was photographed



and measured with a tape and calipers. To derive exact comparisons, adhesive dots were placed at 14 standard "landmarks" on each subject's face. The 360-degree scan itself took about 17 seconds, but postproduction cleanup took up to eight hours per scan.

Photos: Xi Wang; all images courtesy Size China



was in trouble." He sold his share of his then 18-year-old Toronto-based design consultancy to its cofounder and packed his bags for Italy, where he completed the one-year MFA design program at Milan Polytechnic. After a brief return to Toronto, he was offered the position at Hong Kong Polytechnic, where faculty members are required to spend 30 percent of their time on research. He quickly confirmed that while there is plenty of existing research into measuring and codifying body shapes and sizes to help improve fit in the West, with benchmarks like Henry Dreyfuss Associates' 1960 *The Measure of Man* and the more recent U.S. Air Force-initiated Civilian American and European Surface Anthropometry Resource (CAESAR), there is no equivalent in Asia. "I found some very old studies, in Mandarin, from the 1940s or 1950s," Ball says, "but they were very basic: a small sample and only dimensions—not describing shape at all, which is the problem."

The significance of Ball's research proposal was not lost on the Hong Kong government, which provided 85 percent of the \$1 million cost under its DesignSmart Initiative, a collection of funding programs that takes aim at the old perception of Hong Kong as the land of knockoffs. The initiative expressly aims to "instill" into local industries the notion of high intellectual property and creativity content, and ultimately turn Hong Kong into a "focal point of design excellence."

The remaining 15 percent of funding for Size China had to be raised, according to a government stipulation, from at least three industry sponsors. Having spent 25 years as a design consultant to sports manufacturers, Ball brought some business contacts and negotiating skills to academia. An old contact from the Burton project was Norman Cheng, who is president of the Hong Kong-based motorcycle-and-sports-helmets manufacturer Strategic Sports, which produces Burton helmets. Although the company's primary markets are in North America and Europe, the prospect of 1.3 billion helmet-deprived people on its doorstep was enticing enough to merit sponsoring Ball's research. "We intend to use this data to make a range of helmets to start sales in China/Asia," says Cheng, who is Chinese. "Good-fitting helmets are key to our industry, and a scientific study will continue on page 222



PROTOTYPE
The first prototype Size China head form, constructed from scanned data, revealed a dramatic difference between Chinese and Western head and face shapes: Western heads are generally more oval and appear to have had the corners "filled out." The research also revealed that there is no correlation between head size and eye, nose, mouth, and ear sizes.



GLASSES
A model for testing eyeglasses is also expected. Ball hopes to take the guesswork out of buying glasses as well as provide frames that don't slide off Asian noses.

★ Results

Head forms in a range of sizes have been made into prototypes from the Size China data and are now being validated; Ball anticipates ISO [International Organization for Standardization] ratification in the near future. The golden heads will become commercially available this spring, along with the Size China data. Ball (shown right) expects an overhaul of the global sizing system as

a result, with the emergence of "regional sizing systems." Other researchers—including Marc Rioux, at the National Research Council of Canada—are looking for new systems based on visible body parts, which could prove more useful than iris patterns or fingerprints. "If we find that some visible body parts have complex variability, they could be used as markers," Rioux says.



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continued from page tk help us exploit this potential market.”

Last October, Ball gave a presentation of the Size China project at the annual Industrial Designers Society of America (IDSA) conference, in San Francisco, conjuring golden heads from a dark felt sack like a magician. First out was a generic head form used by ASTM International, the American standards-development organization founded in 1898, which sells these heads for testing; the second was the first head form to be derived from the Size China data set. Ball tilted the gleaming heads toward the audience and recited some numbers: with the top of a Western head, the average ratio of length to width is 1:0.74, but the Eastern head ratio is 1:0.86. “If you think back to the snowboarder with the headache, he had a much rounder head. So anything that fits him on length is going to be a bit tight on width.”

On the conference screen, Ball showed some of the photographic documentation of the scanning process, a compelling portrait of a nation undergoing dramatic upheaval shot by photographer Ki Wong. In Gansu Province, in the rural northwest of China where the heavily polluted Yellow River flows through the rapidly expanding city of Lanzhou, wizened Chinese men are pictured, elastic caps on their heads (to prevent digital noise caused by hair shine) and adhesive dots on their faces (for comparative measurement), waiting to be laser-scanned in a traditional wood-frame building. “In a city where the factory workers are, we’d get busy at 5 p.m. through to midnight,” Ball says. “In the village, that’s all they’ve got to do. You’ve just got to stop people being scanned three times because they get some money for it.”

The logistics of scanning in rural China are complex but not insurmountable. Ball’s team sent specifications to each of the project’s six partner universities for setting up a space for scanner equipment, lighting conditions, and the gender and age range of people needed to satisfy the requirements of an anthropometric study (advising consultants were established at research institutions: Delft University, in the Netherlands, and Anthrotech, in North America). Candidates were paid an honorarium (about \$10) for their trouble. “The beauty of this project was that every Chinese person understands it,” Ball says. “When you say, ‘We’re trying to make things that fit you better,’ they say, ‘I’m in.’ Really, it was surprising and shocking. Normally, it’s hard to recruit people for research.”

Aside from chasing chickens out of the scanning room, the Size China team had to battle with time. As part of its contract, the Hong Kong government required that the project be completed in 18 months, despite Ball’s grant proposal specifying a three-year project. Laser-scanning is not a perfect process, and gaps caused by digital noise, shadows, or geometries too complex for the scanner to process (ears are notoriously difficult to scan) have to be filled in manually using purpose-developed algorithms. Twenty-two percent of scans were rejected due to imperfections and irregularities, and each of the 2,000 retained had to be aligned before data could be extracted and used for statistical analysis. Cleanup and alignment took an average of eight hours per scan.

One organization that has been looking carefully at the raw data is the National Research Council (NRC) of Canada, where a group has spent several years analyzing the 3-D data generated by the CAESAR project, primarily for transportation and clothing. Traditional anthropometry, like the military data Dreyfuss used for *The Measure of Man*, characterizes the human body by tape measure and caliper measurements of the distances between given anatomical “landmarks”—the same points marked by adhesive dots on the faces of Ball’s subjects. NRC scientists have developed software that analyzes the data generated in 3-D scans and generates digital body types according to variations on a 3-D grid, disposing of the need for landmarks. Coupled with a search engine that finds similarities in visual shapes, NRC’s method of statistical-component analysis promises to turn product design on its head. Currently, we buy clothes, shoes, and headgear, and sit in car seats or cockpits, designed for average body types under the presumption of a correlation between height, weight, and shape. In fact, two people of the same height and weight can have completely different body (and head) shapes. If software can generate body shapes from specific populations—

like, say, the Chinese women sampled in Size China—then the digital models generated to improve fit will be considerably more sophisticated. NRC researcher Marc Rioux believes this may require a whole new sizing system. “Instead of having small, medium, and large helmets, it could be design A, which would fit fifty percent of the population, design B, another twenty percent, and design C, another ten percent. By understanding the variability of the human shape, we can make products that fit more people.”

“Every Chinese person understood this project,” Ball says. “Normally, it’s hard to recruit people.”

The Size China data is useful to the NRC not only because it samples a relatively homogenous and genetically isolated population, but because it does so at three times the resolution of the CAESAR data. For Ball the data holds the key to another design problem: eyewear. He relates the story of an interview he gave to an Asian journalist writing for the Hong Kong edition of *Cosmopolitan*. The journalist honed in on the problem of finding sunglasses by Western designers that fit Asian heads: “She was a smart, professional, hip young woman,” Ball says. “And she said to me, ‘It’s such a problem for my friends and I. We love those glasses, but we can’t wear them. A couple of us are thinking of getting plastic surgery.’ I said, ‘What? You’re going to get plastic surgery to fit the glasses?’”

Ball had initially assumed there would be a correlation between head sizes and eye, nose, mouth, and ear sizes, which would allow him to create a series of facially featured average Chinese heads. After scanning several thousand subjects he discovered that there is no correlation between the zones of the face at all: “You could have a very large head, very tiny eyes, and a medium mouth, or a tiny head, very big eyes, and an average mouth,” he says. Ball realized that to develop a model head for sizing eyewear, he would have to take only data of the eye zones. “Designing sunglasses is very difficult to do,” he told his San Francisco audience. “What design studios typically do is design them in CAD, make them look beautiful, rapid prototype, and then spend six months fixing the mistakes of the fit.” He showed the audience a model of an eye form derived from the data of five southern-Chinese women. “This is the first eye form in the world which allows you to put the glasses on and see if they fit.”

Not all of Ball’s public appearances go as smoothly as the IDSA presentation in California. He recently found himself presenting to a stony-faced audience in Austria, where consciousness of anthropometry’s use as a means of distinguishing Aryans from Jews in Nazi Germany was more painfully present. “It’s a little bit of a Pandora’s box,” Ball admits. Anthropometry’s origins are in law enforcement: criminologist Alphonse Bertillon’s measurement and classification of physical features preceded fingerprinting as a means to identify convicted criminals in nineteenth-century Europe. The problem lies in the conceptual leap from organizing evidence to developing theories of genetic superiority based on that evidence. Shortly after Bertillon (chief of criminal identification for the Paris police department) invented anthropometry, Italian criminologist Cesare Lombroso began theorizing that criminality was inherited and could be identified by physical “defects.” As an early-twentieth-century means of identifying the races of man, anthropometry was bridled with the imperialistic legacy of presuming that certain of them were superior to others, leading to eugenics. “It’s a dark history,” Rioux confirms, “and that’s probably why the people I’ve talked to who’ve been trained in anatomy are extremely reluctant to do research in it—because people will abuse it, and it has been abused in the past.”

Yet there are plenty of scientific advances with dark histories, and anthropometry’s modern-day proponents argue that the potential benefits are too important to ignore. Rioux points out that the sizing system used for today’s clothing, protective gear, and even interiors of cars and cockpits are practically Stone Age. “Designers really work in the dark, and continued on page tk

Sizing China

continued from page 14 often with data that is really outdated, say thirty or forty years old.” He adds, “One other challenge is that populations change over time. With statistical analysis you can predict changes in body shape, and that has much relevance to the design of aircraft like the Airbus or the Boeing, which have a lifetime of thirty years. The pilots of twenty years in the future will not be the same in terms of body shape as they are today.”

“Designers really work in the dark, often with data that is thirty or forty years old.” Marc Rioux says.
“Another challenge is that populations change over time.”

Ball, who lives in Hong Kong with his Taiwanese wife and two mixed-race children, likes to imagine that one day his data may become irrelevant “when you finally get this completely mixed society. It’s not West or East anymore; it’s something else.” In the meantime, there’s work to be done. Ball will submit the results of Size China to the ISO, which to date has been ignored by many Asian manufacturers. The economic implications for Asian industry are considerable. Size China sets up the opportunity for a kind of innovative product-design regionalism, presenting information for manufacturers to create better-fitting products that might just make the Western knockoffs irrelevant—as well as combating problems like head injuries and fatalities caused by motorcycle and bicycle riders’ not wearing helmets—or wearing ill-fitting ones.

European and American companies might also stand to benefit. One of the project’s sponsors is one of the world’s biggest baseball-cap manufacturers, New Era, which came on board late, after its Hong Kong–based sales executive Andrew Wood saw Ball’s team mentioned in a news item in the *South China Morning Post*. “Given that we’re a fitted-cap specialist and they were doing a fit trial, it seemed an opportunity,” says Wood, whose company, based in Buffalo, New York, sells nearly 40 million caps a year, mostly in the United States. “When I asked our innovations department on what basis were we measuring heads, it was Air Force pilots’ head sizes from forty years ago, which are not really relevant to modern China,” Wood says.

Change is not cheap, of course. Academic researchers can apply for a free copy of the data, but businesses—including sponsors of Size China—have to pay. Wood concedes that the next step for New Era requires considerable further investment, not just in the project data but in design and tooling. “It’s just a question of what the cost will be to bridge that gap,” Wood says, “to buy the data and then utilize it to create specific caps, shapes, and sizes for the China market. Right now we seem to be doing okay without that. The question is how much more could we do by having the perfect fit in China, now and in the future?”

Ball, whose promotional tactics are by now well honed, is convinced that the growing hip-hop contingent in China is obsessed with getting caps to sit at precisely the right angle on the head. But his personal entrepreneurial focus is to use the Size China data to start a business in designing and manufacturing eyewear for the vast Asian market. “I want to make better-fitting sunglasses.”

Back in the classroom, Size China has become Ball’s pedagogical tool for reminding students that usability is product design’s trump card. “It’s reinforced that you’ve got to start from the user,” Ball says, “not only emotionally and aspirationally but also physically, and there are no shortcuts there.” **www.metropolismag.com**