

The amateur mathematicians built upon an existing tradition of hanging wooden tablets with poetry or paintings in Shinto shrines and Buddhist temples, painting or engraving sangaku that typically give the result of a problem but not the proof. "Ostensibly, the tablets were left as gifts to the gods," Fukagawa explains. "In reality, people were showing off and challenging others to work out the proof."

The vast majority of the problems involve plane geometry. But some involve calculating volumes of solids and others deal with algebra-like equations. The sangaku crafters typically included their names and the dates they hung the tablets.

Once Japan ended its isolation in the mid-1800s, the government encouraged the study of the European mathematical tradition as part of its push to catch up to the West technologically and economically. The archaic Chinese characters of Japanese mathematics fell into disuse, and the sangaku tradition disappeared. The rediscovery of sangaku is due in large part to 61-year-old Fukagawa, who holds a degree in mathematics and who has spent nearly 40 years teaching high school math in Aichi Prefecture. Looking for material to enliven his classes, he stumbled upon sangaku. "At the time, no Japanese mathematician had studied sangaku in any depth," he says.

His first step was to teach himself the archaic Chinese characters used on the tablets. The more sangaku Fukagawa deciphered, the more impressed he became with their sophistication. Japanese mathematicians were less enthralled, however, so Fukagawa started contacting geometers in other countries. His search led to a number of collaborations. In 1989 he and Daniel Pedoe of the University of Minnesota, Twin Cities, co-authored *Japanese Temple Geometry Problems*, which remains the most complete monograph on sangaku in any language. In 2002 he and John Rigby of Cardiff University in Wales published *Traditional Japanese Mathematics Problems from the 18th and 19th Centuries*.

The first book describes a number of Western geometrical theorems that were solved independently in Japan. One notable example is Soddy's hexlet, a theorem published in 1936 by Frederick Soddy, a British chemistry Nobel laureate, involving a complex construction of spheres within a sphere. Fukagawa and Pedoe found that the identical solution had been inscribed on a sangaku placed at a shrine in Kanagawa Prefecture in 1822. (The tablet is lost but is described in a written text.)

Even so, the mathematical significance of the sangaku tradition is an open question. Hikosaburo Komatsu, a mathematician at the Science University of Tokyo who studies Japan's indigenous math, agrees that their existence "shows that knowledge of math among ordinary citizens of that time was quite high." But the tablet format limits results so that



"mathematically, sangaku are not very deep," he says. Serious Japanese mathematicians were producing much more significant theoretical work at the time, he notes. Still, Peter Wong, who grew up in Hong Kong and now teaches mathematics at Bates College in Lewiston, Maine, says the sangaku "open up

Sleuth. Hidetoshi Fukagawa has written the definitive text on sangaku.

all sorts of questions" about how laypeople developed sufficient mathematical skills to tackle nontrivial problems.

Fukagawa hopes further study will provide some answers. About 900 sangaku are known to remain, and dozens more that have been lost are known from written references. Only last year, during a visit to a shrine in Mie Prefecture, Wong used his knowledge of Chinese characters to point out a sangaku that Fukagawa had overlooked. Fukagawa also hopes the exhibition, which runs from 19 April to 26 June, will stimulate interest in the topic and yield additional sangaku. —DENNIS NORMILE

Public Health

Provocative Study Says Obesity May Reduce U.S. Life Expectancy

The rising incidence of obesity, especially among children and teenagers, is leading to a variety of diseases that could depress average life span

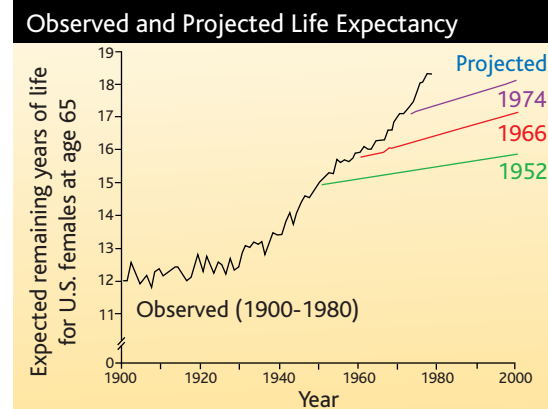
In the 1980s and 1990s, the late maverick economist Julian Simon infuriated environmentalists by arguing that free markets and scientific progress were constantly improving human life rather than pushing the world toward ecological ruin, social collapse, and famine. A key example was life expectancy at birth, which Simon showed had been steadily rising for centuries. Using that as a metric, he repeatedly claimed that in the 21st century, "humanity's condition will improve in just about every material way."

Not so, says a 10-person research team led by S. Jay Olshansky of the University of Illinois, Chicago, and David S. Ludwig of Children's Hospital in Boston, Massachusetts. In

a study published in the 17 March *New England Journal of Medicine*, the team predicts that U.S. life expectancy "could level off or even decline" by 2050.

The culprit, though, is not environmental heedlessness but the very market-driven affluence that Simon celebrated, because it has fostered an explosive rise in obesity, and especially childhood obesity. That rise, the research team argues, has already offset increasing life expectancy "by 0.33 to 0.93 year for white males," with similar offsets for women and other races. Assuming that current trends continue and that no big technical fixes emerge, Olshansky says, "we have strong reason to believe this number will rise rapidly in the coming decades."

That conclusion is likely to be controversial. Critics argue that it is based on a partial reading of the evidence. "Obesity is indeed a problem," says James Vaupel, director of the Max Planck Institute for Demographic Research in Rostock, Germany. "But on the other side there are extraordinary advances being made as a result of biomedical research." Moreover, he says, "the United States has seen a slowdown in life expectancy, but in other countries it's going up fairly rapidly—about 3 months per year in places like France and Japan."



End of an era? Average years remaining for U.S. females at age 65 rose steadily, in spite of projections to the contrary.