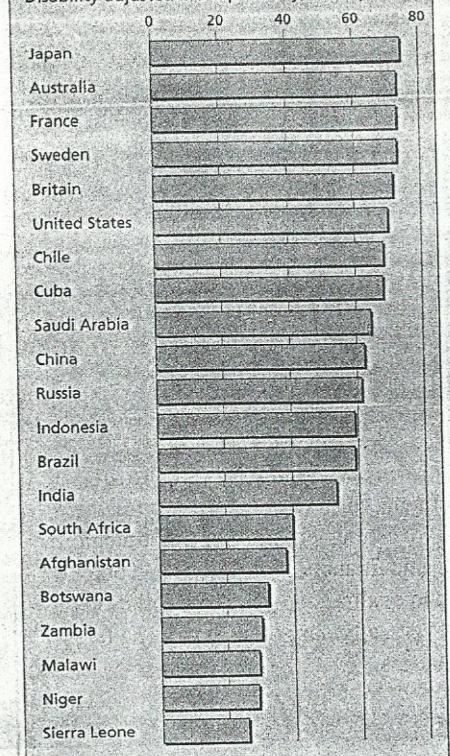
Life worth living
Disability-adjusted life expectancy, 1999, years



Source: WHO

years less than their total life expectancy.

Japan, Australia, France and Sweden all have DALES of more than 73 years. Indeed, the Japanese are not only the world's longest-lived people, with an average life expectancy of 81 years, but, according to this new measure, they are the heartiest, with only 6½ years of their projected lifespan spent in ill health. Low rates of heart disease are credited as one explanation of Japan's strong showing. But the WHO warns that this may change as a consequence of fattier diets in recent years and greater cigarette consumption since the second world war.

At the other extreme, the countries with the worst DALES are in sub-Saharan Africa. The healthy life expectancy for babies in Sierra Leone, Niger and Malawi is under 30 years. AIDS, along with malaria, tuberculosis and other infectious diseases, is ensuring that life remains nasty, brutish and short.

Poverty is a powerful ally of illness; but greater wealth does not necessarily buy better health. America is famously the world's biggest spender on health care, but with a DALE of 70 years, it still falls behind Japan, which forks out far less.

Dr Murray admits that DALE is a rough-and-ready benchmark. Standard mortality statistics are hard to gather in some poor countries, let alone more sophisticated, culturally-sensitive assessments of illness severity. The WHO is busy working on both fronts to make DALE more reliable. If only the same could be said for the Underground. ■

Nanomagnets

Lodestones on the loose

A MAGNET that turns slowly on its axis, always seeking north, has for centuries meant security to a ship at sea. No wonder that in the 16th century British naval helmsmen were flogged if they were caught doing their job with garlic on their breath. That was liable to destroy the magnetic properties of the "lodestone" in the precious compass, was it not?

It wasn't, of course, as any helmsman able to read Latin might have known from "De Magnete", the book that came out of the hobby of Elizabeth I's doctor, William Gilbert. It appeared four centuries ago, before Kepler published his "Astronomia Nova" or Galileo the "Siderius Nuncius", and is regarded by many as the first proper textbook of science. After much experimenting—itself a novelty in those days—Gilbert proposed that the earth was actually a magnet that brought magnets all over its surface into line, whether smeared with garlic or not.

Much has since been learnt about what makes magnets behave as they do, right down to the quantum details. That has led to all sorts of useful things, from electricity generators to NMR scanners that peer deep into the cells of the human body. But Nature's bag of tricks is not empty yet. Ronald Ziolo, Javier Tejada and their colleagues at the Barcelona University Xerox Laboratory for Magnetic Research have made a new material consisting of billions of tiny magnets, freely rotating under the influence of an applied magnetic field, like so many microscopic compasses. It will not appear any time soon on the bridge of a ship, but it might come in handy below decks, as part of the electrical system.

Generating power and transforming it into a useful voltage involves big coils, wound around a core made, for instance, of iron. The job of the core is to intensify the magnetic field generated when a current flows through the coil. In most applications this is an alternating current, and as it flows back and forth the magnetic field also has to reverse its direction many times a second. In a transformer, this reversing field induces a current in another coil around the same core, but at a different voltage.

The material in the core has to go along with these reversals of the magnetic field, but it does so only with some difficulty. Physicists call this the coercivity of the material: the more coercive it is, the more energy is drawn into it, swirling uselessly around in the form of "eddy currents" that dissipate until all that is left is heat—which, as well as being a waste of energy, may also make it necessary to engineer costly cooling arrangements around the transformer.

There are ways to design around this problem. The intensification of a magnetic field by the core happens because its atoms, with their orbiting and spinning electrons, are in a sense tiny magnets. The movement of the electrons can be influenced by an external magnetic field, and if they are inclined to line up with that field, they will collectively reinforce it. The eddy currents, on the other hand, arise because iron, as well as being a suitable core material, conducts electricity. So making a core from thin iron sheets, interleaved with an insulating material, brings the coercivity of the core down without harming its useful properties too much. Some special alloys also do a good job of reinforcing the magnetic field, while preventing eddy currents.

The new material that Dr Ziolo and his colleagues have created is the ultimate step in that direction. They report in the latest issue of the *Journal of Applied Physics* that it consists of a mix of iron oxide, polystyrene and methanol, in which the iron oxide is dispersed throughout the material, in magnetised clumps a few nanometres across. A nanometre is a billionth of a metre, so each clump consists of just a handful of atoms.

The researchers proceeded to wriggle all the clumps loose, by cooling the material to a few degrees above absolute zero, applying a strong magnetic field in one direction, and then reversing it. The result was remarkable: a material consisting of billions of tiny magnets, each rotating in its own cavity. This material reinforces a magnetic field well, since the magnets flip over in a jiffy, without energy-sapping eddy currents.

Such "nanomagnets" join the nano-scale levers and gearboxes that have now been constructed by other scientists. Indeed, the first applications of the new material may be in some instrument working at this not-quite-atomic scale. For example, says Dr Ziolo, left to its own devices a nanomagnet will probably point north like any compass. By sending current through a loop around a single nanomagnet, it should be possible to detect where it is pointing, and thus to use it as a miniature compass or gyroscope. The magnets also react so quickly to the reversal of an applied magnetic field, says Dr Ziolo, that it might be possible to use them as electronic switches in computer chips.

Transformers and generators will probably come later. And last of all, if history is any guide, will nanomagnets get on board Her Majesty's ships. In the American Geophysical Union's journal Eos, celebrating the quatercentenary of Gilbert's "De Magnete", Stuart Malin and David Barraclough note that it was 100 years after the book's publication before flogging stopped being the penalty for a helmsman's bad breath. ■