perception of that same quantity, and uses this difference to drive the behaviour that reduces the discrepancy. A newly hatched duckling, for instance, would have a setting for how near it needs to be to its parent. When the parent is further away, the difference drives the duckling's behaviour, perhaps making it run, to restore the error to zero. According to Powers, this continuous process of perception, comparison and action goes on in many systems simultaneously within any living animal.

Because these adjustments involve many systems, conflict between them is common. An animal might need to regulate its proximity to safety and an optimum level of novelty or stimulation in its environment, for instance. But going closer to novel environments can take the animal further from the safety of its lair. Powers proposes that two systems in conflict have their set points determined by a higher level system. In order for the conflict to cease, these settings need to change. He suggests that a random, trial-and-error change in these settings takes place until they no longer cause conflict — a process known as reorganization. An example is the mechanism by which the bacterium *Escherichia coli* heads towards increasing levels of certain chemicals in a surrounding fluid, known as chemotaxis.

Living Control Systems III is an interactive tutorial rather than a coffee-table introduction, and occasionally, but not crucially, demands mathematical knowledge. Increasingly, academic textbooks are becoming more electronic and interactive. But this book's dual format is inconvenient: it would be easier to absorb the material if it was fully electronic. The computer demonstrations are powerful, and the novice reader may get a good grasp of the theory simply by skipping to the penultimate chapter to experiment with a range of novel displays of perceptual control.

Perceptual control theory has spawned a diverse range of applications within psychotherapy, education and artificial intelligence over the past 50 years. It has been lauded by Carl Rogers, the creator of person-centred counselling; Thomas Kuhn, the philosopher of science; and self-regulation theorists such as Charles Carver. Yet it has still to be accepted within psychology, perhaps because it requires psychologists to accept the same level of precision as in physics, biology and engineering. Whether this animated third volume will prompt that leap is an open question, but it succeeds in being a sophisticated yet colourful demonstration of a contentious theory. ■

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Change begins at home

Climate Change: The Threat to Life and a New Energy Future

American Museum of Natural History,
New York City

Until 16 August 2009

A thin red line snakes along a wall, rising from below knee level to a height of three metres. The long glowing tube plots global carbon dioxide concentrations from the year 1600 — when the world's population was less than 600 million, goods were transported by wheelbarrow and horse-drawn vehicles, and the estimated atmospheric CO₂ concentration was 274 parts per million — until the year 2000. By that time, the world's population had reached more than 6 billion, aeroplanes were plying the skies, and atmospheric CO₂ had topped 369 parts per million. Today, that concentration is at more than 385 parts per million, a level not seen on Earth for at least 800,000 years. Earth is also hotter now than at any time in the past four centuries.

With this grand flourish, the American Museum of Natural History in New York opens its new climate-change exhibition, which runs until August 2009. With displays, interactive videos and dioramas, *Climate Change* clearly and comprehensively provides the facts on global warming. It dispels doubts about the reality of the crisis — of which there are still plenty among the American public.

The exhibition stresses that humans are responsible for the recent rise in CO₂, and that this is linked to a 0.8 °C increase in average global temperatures in the past 100 years. A video installation explains how greenhouse gases such as CO₂ trap heat, and shows how global temperatures and atmospheric CO₂ are rising in tandem. A small model of a coal-powered steam engine, invented by Thomas Newcomen in 1712, ties the rise in CO₂ to the start of the Industrial Revolution. A giant, jagged, one-tonne slab of coal reminds us that this dirty fuel, the burning of which generates nearly twice as much CO₂ as natural gas, still provides 40% of the world's electrical energy.

The effects of climate change are already obvious: longer, drier droughts in the southwestern United States and the North African Sahel, spring arriving earlier, warmer seas that kill coral — a bleached and lifeless model reef sits in one corner — and shrinking Arctic sea ice. This last consequence has forced polar bears to spend more time on land, and a

diorama depicts a stuffed polar bear foraging for food on a pile of snow-sprinkled rubbish — plastic bottles, a discarded television set, a doorless refrigerator. If that sad scene spurs its viewers to change their lifestyles, then the curators suggest plenty of ways to do so. Touch-screen videos invite visitors to click on their current car and see how much carbon it emits. Drive 99 kilometres in a sports utility vehicle every day, and in a year it will cough out more than 14,000 kilograms of CO₂ — enough to fill up two-and-a-half hot-air balloons. The same daily distance in a hybrid-fuel economy car will pump out one-third of that amount.

Many other options are offered for combating climate change: ditch the car and take public transport; avoid bottled water; switch to energy-saving light bulbs; line-dry clothes; fly less; install low-flow showers; pay for wind power; plant trees and shrubs. The exhibition

D. FINNIN/AMNH

Rising seas may threaten cities such as New York.

also considers broader solutions such as carbon capture and storage; wind power — already supplying Denmark with more than 20% of its electricity; hydropower; geothermal and solar energy. More than 25,000 solar panels are now sold every year in Kenya, where they are used to power television sets and recharge mobile-phone batteries.

A final wall display invites visitors to write or draw their own solutions on postcards. "We need nuclear energy" is followed by "Windmills and solar power, not nuclear — until we have a plan for nuclear waste". Another exhorts us to "Promote science education — Study Nature!". But my favourite card offers one simple word: "Vote". ■

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