clear waste disposal in general. Storage facilities for radioactive waste and used fuel elements are believed to be filled to capacity at a large number of nuclear power stations in Russia.

Western countries have been demanding the closure of the Chernobyl plant. The European Union and Group of Seven industrialized nations undertook in 1995 to find a safer and more permanent form of protection for the ruined reactor. The Ukrainian Government agreed earlier to shut the site but it depended on the country getting international aid. This pledge to close the Chernobyl reactor came after years of wrangling about the details of a compensation package to be provided by Western governments. Ukraine has been seeking money to decommission the Chernobyl plant and bring two new generating plants on stream. The promise to close the power station in 1995 in exchange for aid from the G7 group of industrialized nations, has been repeatedly delayed saying it had not received the money. The package of aid from G7 countries to Ukraine, in grants and loans, was worth a total of about $3 billion. Ukraine failed to close the plant by the deadline at the end of 1999, and threatened to continue operation until the end of the plant's natural life in several years' time. One of the key elements of the Chernobyl closure compensation package – work to make safe the shelter around the stricken fourth reactor – has gone more smoothly. An unstable chimney towering above the reactor was stabilized in 1998. Some of the beams inside the shelter were reinforced in 1999. As of January 2000, the European Union and 25 other countries had committed nearly $600 million of the $768 million that the work on the shelter is expected to cost. The rest of the money is still being sought. Among the next steps planned are efforts to limit the contamination that would result – because of earthquake, accident or extreme weather – if the shelter were to collapse. Once the project has been completed, in 2005, it is envisaged that the sarcophagus will remain safe for another 50 to 100 years. By this time the outlines of the final solution should also have been sketched. Ideas proposed so far include constructing a hermetically sealed dome over the existing plant, or, more ambitiously, removing the radioactive debris and returning Chernobyl to a green field site.

The 6 June 2000 announcement has stated that the damaged Chernobyl nuclear power station is to close permanently in December. The news was announced in a joint statement issued by US President Bill Clinton and the Ukrainian President Leonid Kuchma, during Clinton's brief visit to Kiev. The closure pledge given by Kuchma in the presence of Clinton is reported to be unconditional. The American president hailed it as an 'historic announcement' and said that the US would provide $78 million to help contain radiation from the destroyed reactor. Kuchma said it had not been an easy decision to agree to close Chernobyl but it was a logical one. 'The aim of this decision is to reduce nuclear risks in the world,' Kuchma said. Clinton is said to have undertaken to ask the G7 for assistance in shouldering the costs. The US will also provide a further $2 millon for safety measures at other nuclear power plants in Ukraine.

On 4 July 2000 Western donors from more than forty countries gathered in Berlin to discuss ways to help increase safety at the Chernobyl plant. At the end of two days of meeting, they have pledged an extra $370 m to make safe the Chernobyl nuclear reactor. This brings to $715 m the fund pledged by international governments for the urgent repairs to sarcophagus, close to the sum Ukraine needs for the repairs.

Although Chernobyl remains unfortunately the most severe civil nuclear disaster caused by a combination of human and design issues, it may not be the last. There are currently 430 commercial nuclear power reactors operating world-wide. Ten years after the Chernobyl accident, the world has yet to meet the challenge head on of mastering the most complex and dangerous energy source yet devised by humankind, namely, nuclear power. The Chernobyl event represents the extreme case where a substantial portion of the fission products in the reactor core and some of the fuel were released directly to the environment. It also represents the first time that nuclear process-related deaths occurred at a commercial nuclear power facility and the offsite public was affected by events at a plant. Chernobyl's closure is inevitable and probably overdue.

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# Silicon devices with biological functions

The next time you need to spot a relative, or a friend on a railway platform, think of what functions your brain has to perform. It has the enviable task of identifying one particular individual, amongst an otherwise continuous multitude of humanity available in the field of vision. Talking in terms of electronic circuits, these are incompatible functions. If identification of the particular individual corresponds to the state 0 or 1 of a digital circuit, which is by definition a nonlinear operation, the signal from the general background of people is akin to an analogue response. The neuronal circuits of the neocortex do not respect this distinction. A question naturally arises – is it possible to train an electronic device to do the same?

In a recent publication in *Nature*[1], researchers rom ETH, Zurich, Bell Laboratories, New Jersey and MIT, Massachusetts have shown an alternate way to build a silicon device modeled on biology. Each neuron is represented by an electronic circuit, whose status is active when the circuit produces an output current, while inactive otherwise. No negative current values are possible. A total of 16 such active circuits, representing neurons, are placed together in a ring. Each neuron makes a (synaptic) connection of variable strength onto itself and onto its nearest and next nearest neighbours, capable of carrying forward excitatory interactions. In addition, each circuit is connected to a single central neuron that is trained to induce inhibition.

When a circuit element (neuron) is stimulated independently, the response profile is seen to center on the stimulus and extend over a large fraction of the ring. Such distributed representations have indeed been seen in several brain areas while plotting the tuning curve of a cell, and are called population codes. In the circuit this is achieved by a balance between recurrent excitation and inhibition, which is built in. A remarkable achievement of the circuit takes place when a background is added. The population response remains in the same location (neuron) and with similar shape, but with amplitude that varies with the total amplitude in an almost linear way.

While the response of the circuit is determined by the foreground and background stimulus, two localized stimuli compete to determine the response similar to the tuning curve. When the stimuli amplitudes are vastly different, the circuit always selects the larger stimulus. On the other hand, if they have roughly equal amplitudes, one of them is chosen because of bistability which allows the circuit to retain memory (similar to a Schmitt trigger). But why does digital selection exist with analogue response? This is because of differential instabilities which is necessary for constrained selection, and the possibility of multistability.

Nature around us provides enormous examples of non-digital computing machines. The work of Hahnloser *et al.* demonstrates that we already know enough to build integrated circuits that compute like biology.

1. Richard, H. R., Hahnloser, Sharpeshkar, R., Mahowald, M. A., Douglas, R. J. and Seung, H. S., *Nature*, 2000, **405**, 947–951.

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# Hughes medal for C. N. R. Rao

C. N. R. Rao of the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore has been awarded the Hughes Medal of the Royal Society in recognition of his contributions to the field of materials chemistry, particularly in relation to the studies of the electronic and magnetic properties of transition metal oxides at high temperature superconductors.

The Hughes Medal is awarded in recognition of an original discovery in the physical sciences, particularly electricity and magnetism or their applications.

The Hughes Medal was awarded previously to C. V. Raman in 1930 for the discovery of the Raman Effect.

Rao will receive the Medal during the Society's anniversary day meeting on 30 November 2000.

# Volvo Environment Prize for Amulya Reddy

Amulya Kumar N. Reddy formerly professor at the Indian Institute of Science, Bangalore has been chosen for this year's Volvo Environment Prize. He shares the award with José Goldemberg, (Brazil), Thomas B. Johansson (Sweden) and Robert H. Williams (USA).

This year's awardees have been recognized for their outstanding collaborative achievement since the early 1980s of working out a new policy-driven approach to the technical analysis of world's energy needs and how they could be provided for the early decades of the century.

The Prize which is worth approximately 1.5 million Swedish Kroners will be awarded at a special ceremony in Goteberg in October this year.