100 YEARS AGO

The current number of the *Lancet* has a note interesting to the vast army of cyclists. After a "spin" along a more or less dusty road the cyclist sometimes experiences a dry and subsequently sore and inflamed throat. Headache and depression often follow, and the symptoms generally simulate poisoning of some kind. When the bacteriology of road dust is considered, these effects are hardly to be wondered at. … Indeed, there can be no reason for doubting the infective power of dust when it is known that amongst the microbes encountered in it are the microbes of pus, malignant œdema, tetanus, tubercle, and septicæmia. The mischief to riders as well as to pedestrians would probably be largely averted if, as nature intended, the respirations were rigidly confined to the nasal passages, and the mouth kept comfortably though firmly shut. … A useful precaution, therefore, in addition to exclusively breathing through the nostrils, would be to douche the nasal cavity, after a dusty run or walk, with a weak and slightly warm solution of some harmless antiseptic.

From *Nature* 14 July 1898.

50 YEARS AGO

With the progress of chemistry, and particularly of organic chemistry, it became extremely useful to denote certain definite groups of elements which pass from compound to compound apparently as units with special symbols; thus in addition to the symbols of the elements, we have 'Me' to represent the methyl group or radical, 'Ph' the phenyl group, and so on. Nevertheless, it was unusual to find such abbreviations in the text of chemical books and papers. Even more complicated substances are now being identified, particularly in the field of biochemistry, and with each new compound the urge to find and use abbreviations seems to grow. Adenosine triphosphate soon became 'ATP'; then there was 'ADP' (adenosine diphosphate); many others will come to mind. No one can blame workers in the rush of discovery jotting down abbreviations in their own notes, or even using them in writing down a reaction in symbols. But should they be used in the text of a paper?

From *Nature* 17 July 1948.

Bioremediation

Incas and alders

Peter D. Moore

The myth of the noble savage, living in close harmony with nature and peaceful coexistence with fellow creatures, has generally been abandoned by palaeoenvironmentalists. Evidence from several parts of the world confirms that the environmental destruction brought about by early societies was often remarkable when considered in the light of their generally poor technological development and low population densities.

But were any of our ancestors sufficiently environmentally aware to take remedial action to protect the environment, and hence the resources upon which they depended? Pollen analytical studies of a lake in the central Peruvian Andes, carried out by Alex Chepstow-Lusty and colleagues[1], furnishes one case in which it seems that they were. From this evidence, the Inca peoples in the area may have at one time adopted a bioremediation programme to prevent soil erosion.

The arrival of prehistoric human cultures in new locations, or the development of new technologies in areas long occupied by people, has often resulted in environmental changes that we could regard as detrimental (reduced vegetation biomass, species extinctions, soil erosion). Even before the arrival of the Romans in Britain, the forests of the uplands had been stripped and replaced by moorland and blanket mires[2]. The arrival of Polynesian peoples in New Zealand resulted in a decline of the tree genus *Dacrydium* and an expansion of bracken as forests were cleared[3]; the giant moas also went into decline and eventually became extinct (although the cause remains a matter of controversy). The artistically talented inhabitants of Easter Island had destroyed the jubaea palm, a vital resource for their existence, and had begun their cultural decline well before the discovery of the island by Captain Cook[4]. And so the list goes on, dispelling any notion of primitive husbandmen maintaining equilibrium with their environment.

The picture of the early inhabitants of the Peruvian Andes follows a predictably similar pattern[5], with a deforested landscape already in existence some 4,000 years ago. According to the pollen and stratigraphical record of a small lake at 3,300 m altitude that has been investigated by Chepstow-Lusty and his colleagues[1], charcoal was abundant around 4,000 years ago, indicating the management of vegetation by burning. Grasslands were present, probably grazed by domesticated herds of camelids, and disturbed agricultural soils encouraged an abundance of weed colonists, such as *Ambrosia*. The arable crop of the time was probably quinoa (*Chenopodium quinoa*), which cannot be identified specifically on the basis of its pollen grains because it can be confused with various weed species from the same family (Chenopodiaceae).

The abundance of pollen of Chenopodiaceae and of *Ambrosia* declines after about AD 100, which the authors explain by a general reduction in temperature that is indicated from many sources of evidence in the region, including ice cores[6]. Burning and pastoralism took over from the cultivation of quinoa, but there is also evidence for the introduction of maize as a crop during this period. This land-use system evidently proved inappropriate for the local landscape and climate, because the silting of the lake shows increasing soil erosion, and by AD 1050 the Tiwanaku civilization had collapsed.

It is at this stage that an unusual combination of events took place. The pollen record demonstrates a sudden expansion of alder trees, probably the species *Alnus acuminata*, a colonist of degraded soils. This in itself could be explained by the natural recovery of vegetation following a reduction in human activity in the area, especially as the temperature was increasing at the time. But the post-1050 period was also a time of new colonization by Inca peoples from the south, the Inca capital of Cuzco being situated only 85 km to the southeast of the study site.

Archaeological evidence suggests that these peoples constructed irrigation canals and terrace systems for maize agriculture. The combination of this increased agricultural efficiency with the expansion of *Alnus* can be explained, according to the authors, by the development of an agro-forestry system, using *Alnus* trees to stabilize slopes and reduce soil erosion. If this interpretation is correct, it is a rare example of early conservation practice, especially in the use of trees for soil stabilization.

The Spanish conquistadores arrived in the area during the 1530s and the Inca civilization went into rapid decline. The *Alnus* trees followed suit, presumably being exploited by the invading peoples as a source of firewood, but also affected by the falling temperatures of the Little Ice Age.

The seventeenth-century poet John Dryden's romantic image of the primitive lifestyle — "Free as nature first made man, ere the base laws of servitude began, when wild in woods the noble savage ran" (*The Conquest of Granada*) — may not be justified by the general run of palaeo-environmental data. But from the Peruvian pollen record we can surmise that these mountain peoples managed their landscape in an environmentally aware and agriculturally informed manner. The studies may also present a model for the development of modern agroforestry practices in the Andes, using native trees rather than fast-growing exotics. Our ancestors may not have been truly ecologically noble, but neither were they entirely lacking in environmental sensitivity. □

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Display technology

Printing screens

Robert Wisnieff

The paperless office has long been predicted as the ultimate goal of electronic information systems, but now paper is fighting back. On page 253 of this issue[1], Jacobson and colleagues at the MIT Media Laboratory describe a cheap electronic ink that can be printed on flexible substrates, including paper. The ink is a dispersion of tiny particles inside microcapsules, and it can be changed from white to black simply by applying an electric field. Its appearance approaches that of newsprint; and when combined with an addressing circuit, the electronic ink could even be used to make paper that can print on itself.

The approach of the MIT group is radically different from that of the rest of the display industry, which has concentrated on building liquid-crystal displays on glass substrates. Their new electronic ink is based on a suspension of white particles in an absorbing dye, held within 40-μm-diameter urethane microcapsules. Because the white particles are more electrically polarizable than the dye, they can be moved around by applying an electric field. When the particles are moved to the far side of a microcapsule it appears dark; when they are on the near side it appears bright (Fig. 1).

The electronic ink is bistable: it will remain in the reflecting or absorbing state without consuming power until it is switched. And this technology is far more durable than earlier electrophoretic displays. Previously, instead of being used in an encapsulated form, electrophoretic particles have been held between two plates. Particle clustering and migration across the plates always meant that these displays became degraded after a few hundred thousand cycles, whereas the new ink has already been tested for more than ten million cycles.

To commercialize this work, a company called E Ink has been formed. Named by *Fortune Magazine*[2] as one of 12 "Cool Companies" for 1998, E Ink has attracted a lot of attention and $15.8 million of investment. The company will probably concentrate on producing electronic signs and other low-resolution, low-pixel-count devices (with less than 10 pixels per inch and fewer than 10,000 pixels altogether), using a separate address circuit for each pixel.

The new electronic ink is a good choice for such large-area applications because of its low cost per unit area. Whereas conventional liquid-crystal displays use two sheets of glass, which must be separated by several micrometres and made in a clean-room, the electronic ink can simply be printed on cheap materials such as paper, plastic or metal.

The key to success in other applications will be to develop higher-content displays. It is not economically feasible to directly drive each pixel in a high-content display, so instead some sort of matrix addressing must be used. Matrix addressing uses an *x*–*y* grid of wires with pixels at their crosspoints and the voltage drivers at the ends of the rows and columns (Fig. 2). This allows many pixels per drive circuit. In a simple matrix display, only the display element is located at the crosspoint; but this set-up requires a sharp voltage transition between the black and white states, and electronic ink does not have such a sharp transition. It is better suited to active-matrix techniques, where another electronic component is added at each crosspoint to sharpen the voltage response.

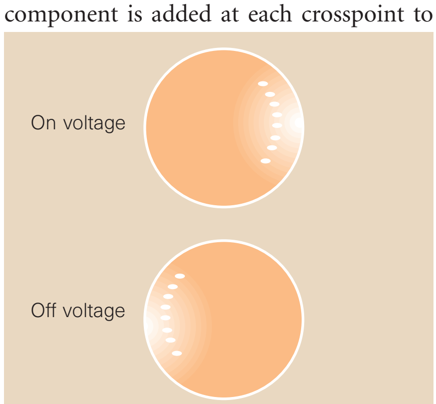

Figure 1 **Switching ink: a voltage moves encapsulated white particles to the right (turning the ink 'on', viewed from that side) or the left ('off').**

Diodes are the simplest suitable components to add, and Jacobson and colleagues have already made a printed metal–insulator–metal diode display. But diode-based active matrices require extremely uniform current–voltage characteristics for all of the diodes in the array, and also small diode areas to minimize the capacitance. Transistors would require more processing steps, but would loosen the requirements of electrical uniformity and size.

What systems might be in competition with electronic ink? A lot of work has gone into liquid-crystal systems, notably in the super-twisted nematic (STN) mode. This type of display has an extremely sharp voltage transition between black and white, so simple matrix addressing can be used. It is widely used in pagers, cell phones and hand-held personal digital assistants. But the reflectance of STN displays is worse than that of electronic ink, and STN displays are not bistable — so the image is lost when the power is cut. These are considerable drawbacks in many applications.

Another possibility is the cholesteric liquid-crystal mode, which can use a simple matrix-addressing scheme to address a high-content display that is bistable and has better reflectance than STN, as well as multiple colours[3]. But this display requires several liquid-crystal cells to be stacked, which means a more complex manufacturing method than conventional liquid-crystal displays.

In Japan, Toshiba and Sharp have exhibited prototypes and announced plans to manufacture reflective active-matrix liquid-crystal displays. The prices of these displays are expected to be comparable to existing, back-lit, colour displays that are used in notebook computers.

But none of these technologies is likely to compete for cheapness and mechanical

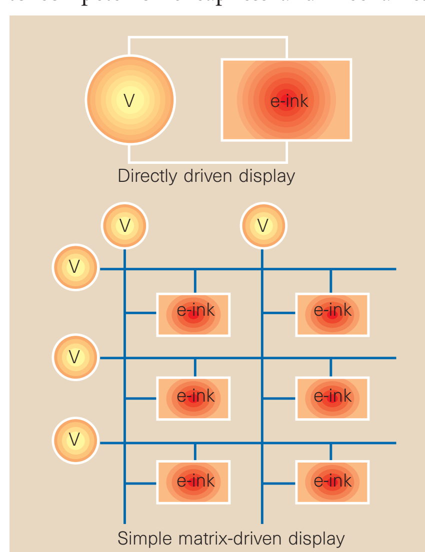

Figure 2 **To go beyond a trivial one-element display, pixels are arranged on a grid, with voltage drivers at the end of each row and column.**