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SCIENCE

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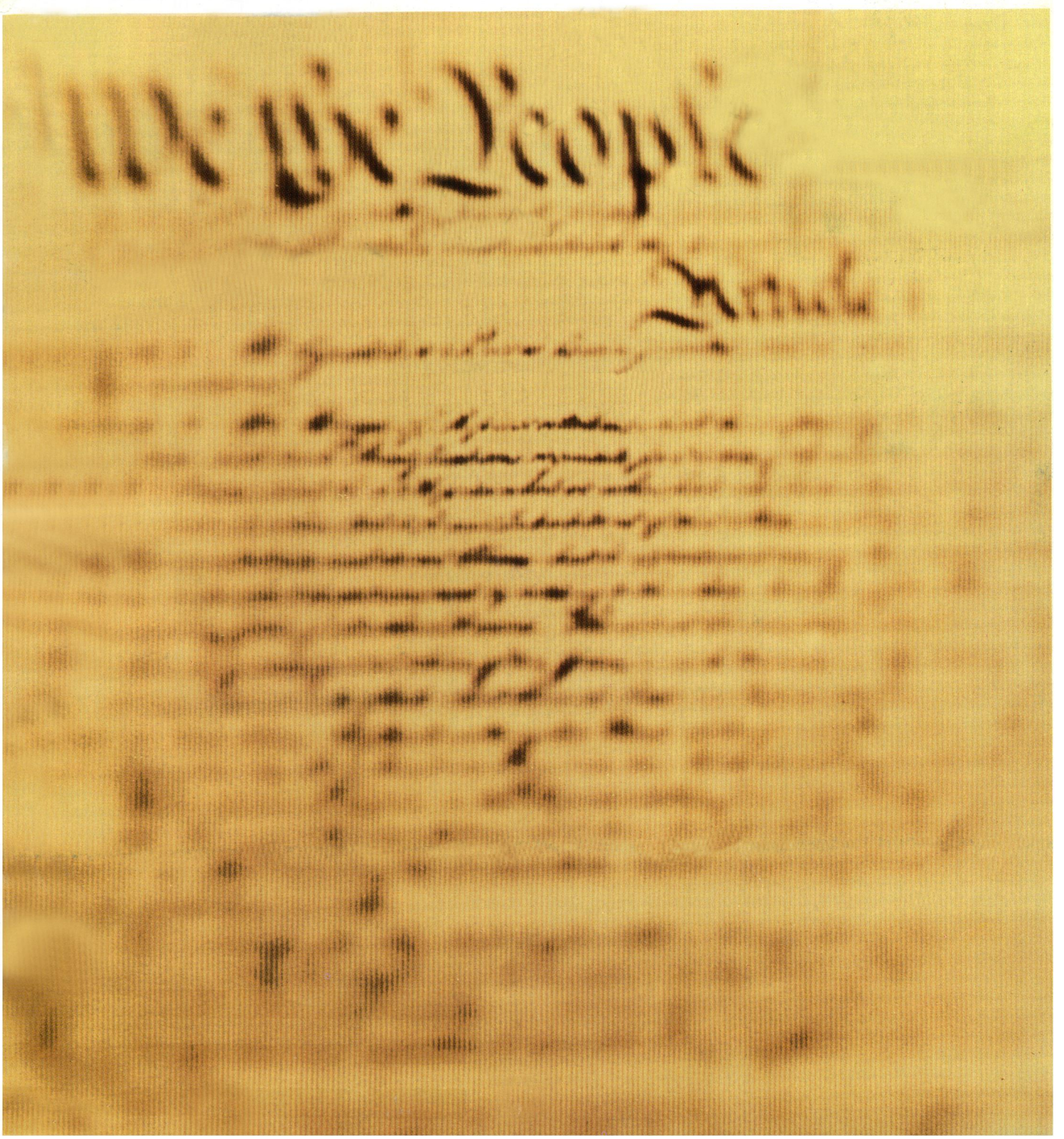

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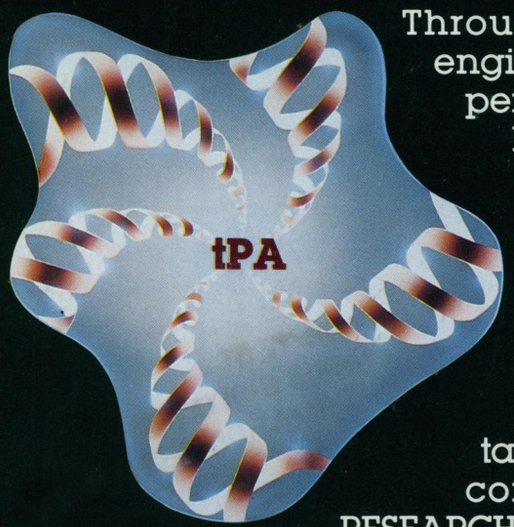

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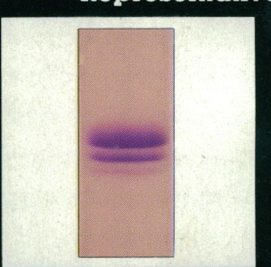

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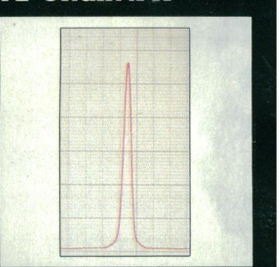

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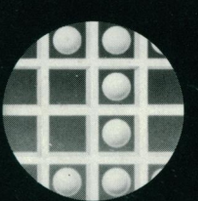

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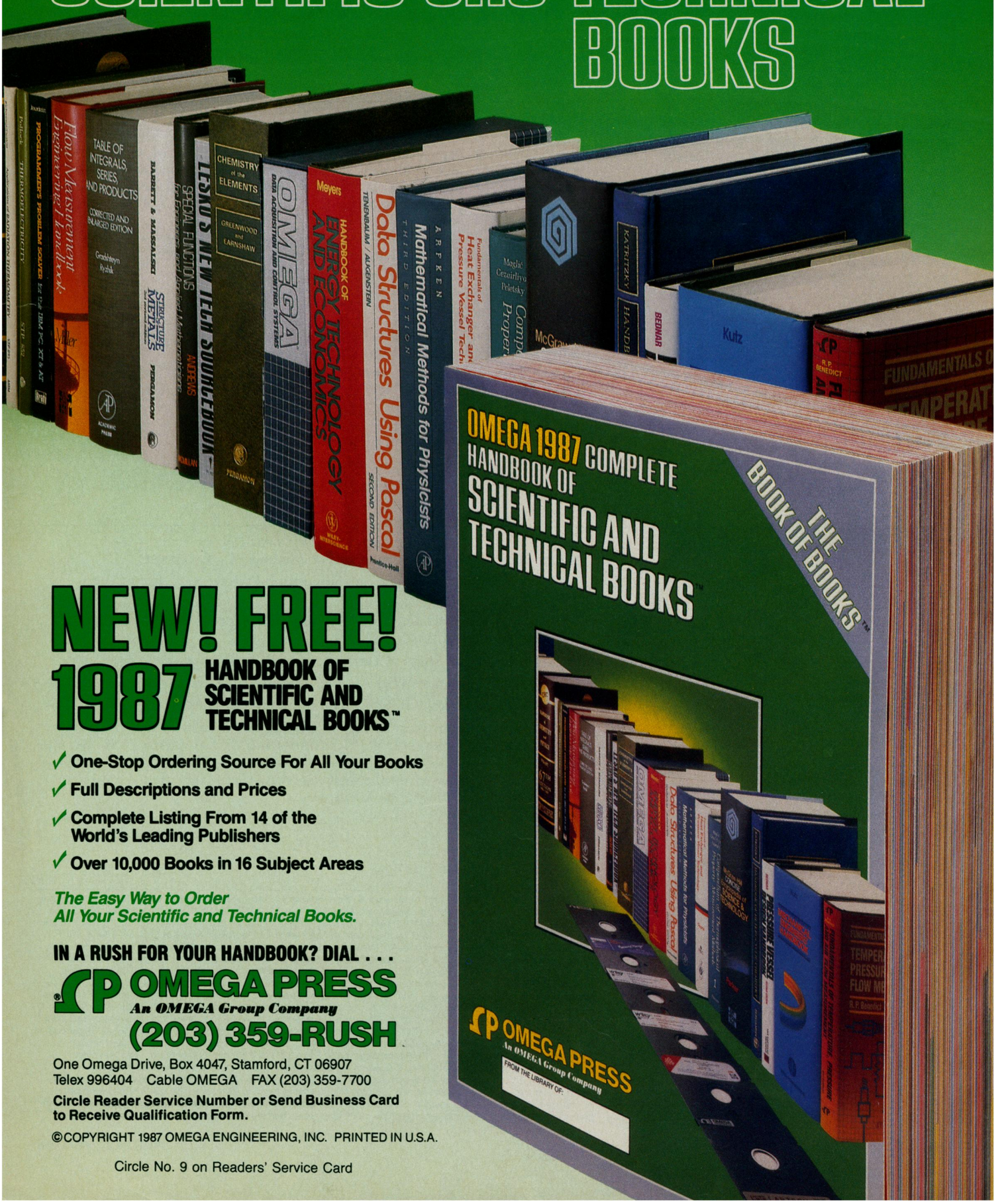

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COVER Computer simulation of the brain's view of the opening passage of the U.S. Constitution. Each point on the image represents the activity of a retinal ganglion cell viewing the corresponding part of the original document. The image is sharp only in the fovea, which is viewing a point several lines below the large word "People." The illustration shows the rapid decrease in acuity for small features (high spatial frequencies) as a function of distance from the fovea. This effect of the spatial tuning of the nonfoveal retina is much more apparent in viewing printed text, which is dominated by such small features, than in viewing other kinds of scenes. See page 73. [Josh Wallman, Christopher M. Harris, and Michael D. Gottlieb, City University of New York]

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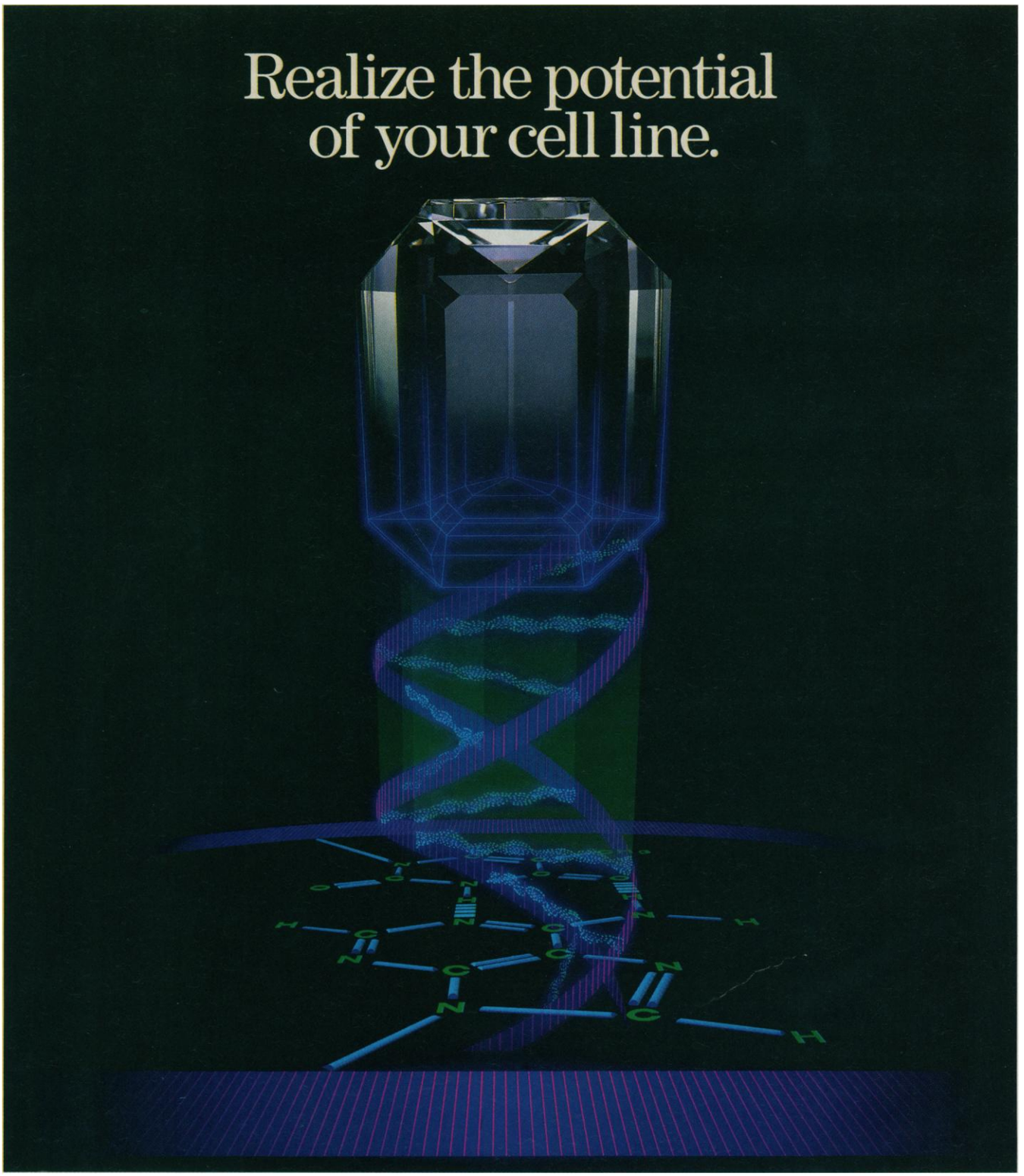

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Changes in the ozone layer

THE natural layer of ozone in the stratosphere shields the earth from damaging ultraviolet radiation, initiates key chemical reactions, and affects the earth's energy budget and temperature. Ozone is produced by photodissociation of O_2 with subsequent reaction of the oxygen atoms with other molecules of O_2. The production of ozone is counterbalanced by catalytic destruction by oxides of nitrogen and hydrogen and other molecules and by direct processes involving oxygen-only reactions. Anthropogenic catalysts such as NO, HO, and Cl from synthetic chlorofluorocarbons can be sufficiently active to cause a net decrease in ozone in the atmosphere. Methane released into the atmosphere by ruminant animals, rice-paddy soils, swamps, and termites, and from natural gas exploration and coal mining also affect atmospheric ozone and other chemical cycles through a variety of chemical reactions. Cicerone (page 35) reviews the processes that create and destroy ozone and marshals some of the evidence that human-induced perturbations in the ozone layer, possibly including the Antarctic ozone hole, may be occurring already.

Developmental patterning in hydra

THE patterning of developing tissues has been studied in hydra by several laboratories and is thought to be the product of a set of developmental gradients. The best studied of these, the head inhibition gradient, behaves as if it results from an inhibitor that is produced in the head of the animal and diffuses through the tissue of the body column, preventing the tissue from forming another head. Communication from cell to cell by way of gap junctions has been proposed for transmission of head inhibition down the body. Fraser *et al.* (page 49) have used indicator dyes and antibody to gap junction proteins to study this developmental gradient. The rate of transfer of injected Lucifer yellow dye from cell to cell was consistent with the rate of spread of head inhibition predicted from previous grafting experiments. When hydras were treated with antibody to gap junction protein, cell to cell communication of dye was inhibited. In grafting experiments, antibody disrupted movement of the putative head inhibitor and allowed formation of secondary heads. The experiments show that gap junctions play a role in the patterning of hydra tissue by permitting exchange of diffusible substances between cells. A similar experimental approach might be used in other multicellular systems.

Hydrocarbons from early solar nebulae

POLYCYCLIC aromatic hydrocarbons (PAHs) such as naphthalene are extremely stable planar molecules composed of fused hexagonal rings. Interplanetary dust particles (collected from the statosphere at altitudes of 18 to 20 kilometers) and meteorites may contain material that is similar to PAHs, as shown by Raman spectral analysis and determination of deuterium enrichment ratios (page 56). Allamandola *et al.* point out that the Raman spectrum of the organic fraction of interplanetary dust particles is similar to the spectrum obtained from the Orion nebula. The ratio of deuterium to hydrogen in the particles is consistent with bombardment of PAHs with ultraviolet radiation in the interstellar medium. These observations suggest that the interplanetary dust particles contain material that has not been substantially altered in structure or function since its formation long ago in the circumstellar envelopes of distant stars.

Archean microfossils from Western Australia

NEWLY discovered microfossils from the Warrawoona Group of Early Archean age in Western Australia provide evidence consistent with the presence of oxygen-producing photosynthesis more than 3.3 billion years ago (page 70). Schopf and Packer found cellularly preserved filamentous and colonial fossil microorganisms in carbonaceous cherts in the Towers Formation and Apex Basalt of the Warrawoona Group; they closely resemble extant cyanobacteria in size and structure. These fossil bacteria are among the oldest ever found. Modern cyanobacteria are characterized by oxygen-producing photoautotrophy and, by analogy, oxygen-producing photosynthesis may have been occurring in Early Archean time. This scenario is an alternative to the view that only sulfide-based photosynthesis was operative at that time.

Amyloid beta protein messenger RNA

A synthetic probe for the messenger RNA that encodes amyloid β protein has been used to map the distribution of cells that express the gene for amyloid in the hippocampus and cortical regions of cynomolgus monkeys, normal human brains, and the brains of patients with Alzheimer's disease (page 77). The amyloid β protein and other cytoskeletal proteins have been implicated in the formation of the neurofibrillary tangles and neuritic plaques that are characteristic of Alzheimer's disease. Bahmanyar *et al.* found that the messenger RNA encoding amyloid β protein is present in cortical neurons from normal monkeys, normal humans, and patients with Alzheimer's disease. It is preferentially expressed in the large pyramidal cells of layers III and V of the prefrontal cortex areas that are involved in the degeneration of Alzheimer's disease. However, other brain regions express large amounts of amyloid β messenger RNA but appear to be spared in the disease. The presence or absence of additional molecular factors may be involved in the pathologic accumulation of the amyloid β protein in Alzheimer's disease.

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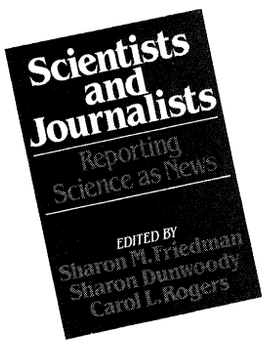

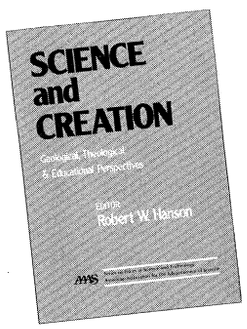

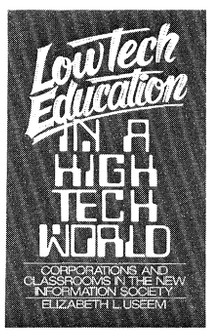

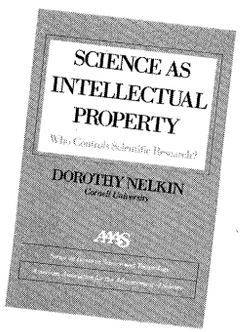

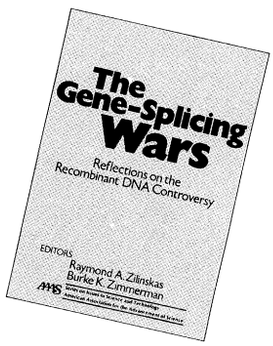

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Inexorable Laws and the Ecosystem

It has been said that the three laws of thermodynamics can be paraphrased. First law: "Life is a zero sum game." Second law: "You can't win." Third law: "You can't get out of the game." The same appears to be true of the global environmental problem. We have only one atmosphere whose balance between carbon dioxide, oxygen, and ozone is critical to our survival. We have one earth and ocean whose fertility and purity are equally important. Increasing population and increasing industrialization pose threats to that environment, the consequences of which will fall on all, except for a few who plan to live out their lives huddled in rockets speeding toward Mars.

No area is more plagued with toxic logic or eutrophied emotions. Highly developed countries are appalled at the destruction by poaching of the great lions and elephants of Africa, but starving residents say that they are only doing what their ancestors did to survive. The World Bank now recognizes that its loans may help encourage the destruction of rain forests, but recipients of the loans may consider farmlands more important than rain forests. In California there is a bitter war between residents of the north and the south over a plan to divert water to southern farmers at the expense of the natural beauty and possibly the environmental quality of northern regions. The tendency for each nation or village or region to point a finger and say, "They're no better than I am," will ultimately doom the ecosystem for all of us. The recent willingness of the U.S. finally to sign a treaty on atmospheric pollutants is a timely recognition that we are all in this atmosphere together.

As the world population grows and as underdeveloped nations become more industrialized, the threat to the environment is going to increase, and very drastically. But before the self-righteous sermons begin, the United States might well examine its own policies to provide belt-tightening models. How can a highly industrialized nation, where there are often two cars per family, make a case to developing nations, where few have even one car, that the world can support no more cars?

The suburban sprawl of the United States is continually overrunning the best farmlands of the country. Yet a chicken in every pot and a home for every citizen is still one of the alluring goals of our society. Are we willing to contemplate restrictions to our freedoms in order to preserve agricultural lands and to concentrate people in more urban areas, thus saving on mass transportation and diminishing the need for individual cars? That solution not only makes sense for the environment, but also for the energy crisis that is bound to come in the not-too-distant future. It is the kind of sacrifice, however, that might be difficult for any political party to support.

With the problem outlined in global terms, it is clear that a rethinking of priorities is necessary. The population explosion has to move to top priority. There is no way that the problems from cars, chemicals, bad land use, and so on, will not accelerate if the population keeps increasing. There is an air of condescension and superiority if industrialized nations with near-zero population growth tell others to "grow no more," but many are coming to the same conclusions for reasons of political stability and economic well-being. Second, better global planning and national priorities need to be established in transportation policy. Third, containment of toxic wastes, acid rain, and other pollutants that poison the atmosphere, the waters, and the land will have to be initiated at high cost to all citizens.

Perhaps the politically feasible line is a negotiated equality of sacrifice. Thus, it is easier for a wealthy nation such as the United States to apply rigid smog controls and develop the technology for waste disposal than an emerging nation such as South Korea. A significant fraction of Superfund should therefore be devoted to research that benefits all. Emerging nations could make their major contributions to programs for effective population control and tailor the research and experience of others to their own pollution problems. Through international treaties, steps toward more appropriate conservation and preservation measures should be taken. Cheap water and cheap air, like cheap oil, are rarely really cheap. Usually one group of citizens must be subsidizing the needs of another group.

It is time to take a global look at the policies and priorities that are dooming our ecosystem. In contrast to the paraphrased second law, we can win, but only if we recognize the truth of the first and third laws. We all win or lose together, and no one can be excused from the game.—DANIEL E. KOSHLAND, JR.

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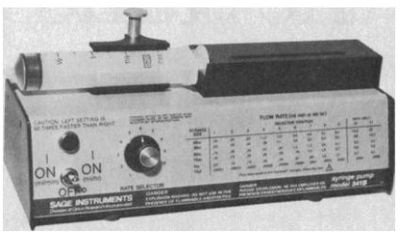

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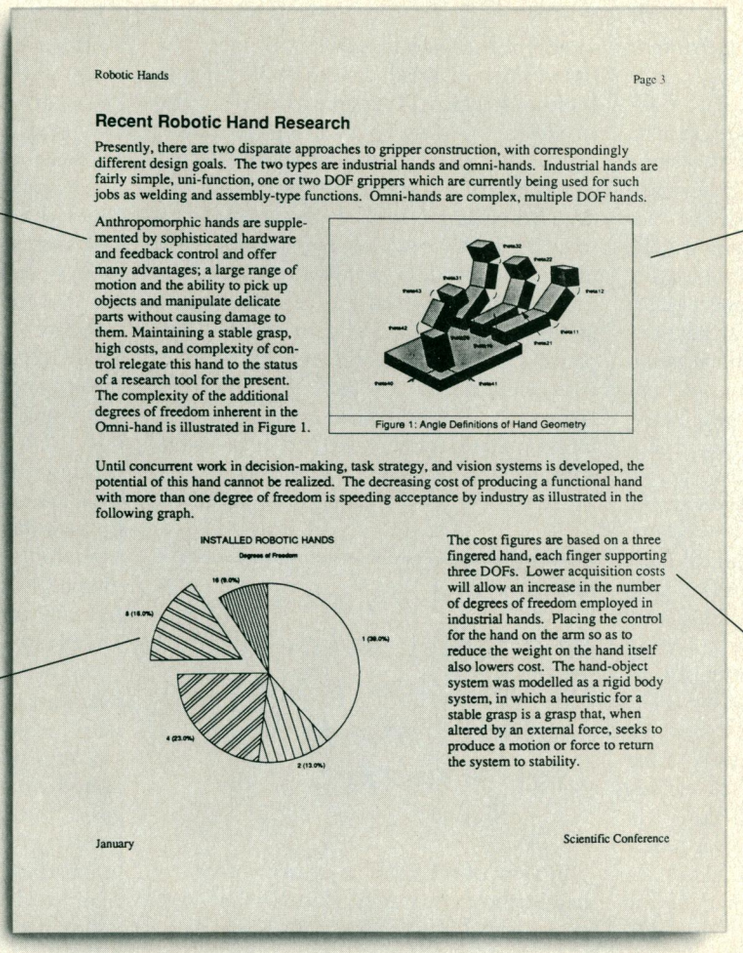

Robotic Hands Page 3

Recent Robotic Hand Research

Presently, there are two disparate approaches to gripper construction, with correspondingly different design goals. The two types are industrial hands and omni-hands. Industrial hands are fairly simple, uni-function, one or two DOF grippers which are currently being used for such jobs as welding and assembly-type functions. Omni-hands are complex, multiple DOF hands.

Anthropomorphic hands are supplemented by sophisticated hardware and feedback control and offer many advantages; a large range of motion and the ability to pick up objects and manipulate delicate parts without causing damage to them. Maintaining a stable grasp, high costs, and complexity of control relegate this hand to the status of a research tool for the present. The complexity of the additional degrees of freedom inherent in the Omni-hand is illustrated in Figure 1.

Figure 1: Angle Definitions of Hand Geometry

Until concurrent work in decision-making, task strategy, and vision systems is developed, the potential of this hand cannot be realized. The decreasing cost of producing a functional hand with more than one degree of freedom is speeding acceptance by industry as illustrated in the following graph.

INSTALLED ROBOTIC HANDS

Degrees of Freedom

10 (5.0%)
8 (15.0%)
1 (38.0%)
4 (23.0%)
2 (13.0%)

The cost figures are based on a three fingered hand, each finger supporting three DOFs. Lower acquisition costs will allow an increase in the number of degrees of freedom employed in industrial hands. Placing the control for the hand on the arm so as to reduce the weight on the hand itself also lowers cost. The hand-object system was modelled as a rigid body system, in which a heuristic for a stable grasp is a grasp that, when altered by an external force, seeks to produce a motion or force to return the system to stability.

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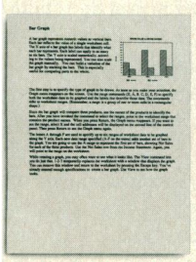

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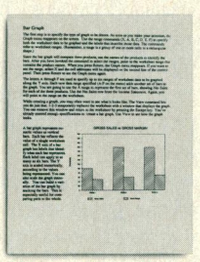

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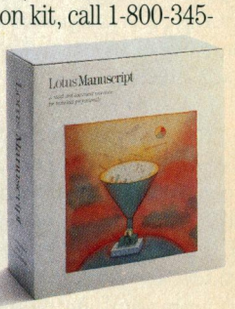

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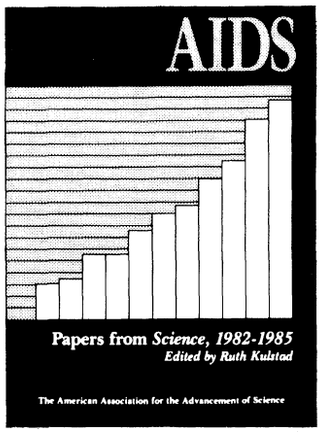

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