
MURRAY
GELL-MANN

Where Are Our Efforts Leading?

A birthday celebration connects topics on the fundamental laws of nature and on international cooperation and environmental conservation—among others.

"All my life I've been concerned that human beings learn to understand nature, which includes ourselves, and that we learn how to get along with nature, which includes getting along with one another."

With these words Murray Gell-Mann, Caltech's Robert A. Millikan Professor of Theoretical Physics and the final speaker in a two-day conference celebrating his 60th birthday, summed up the diverse interests that had established the theme of the conference. The topics ranged from elementary particle physics (the field in which Gell-Mann won the Nobel Prize in 1969) and quantum cosmology (one of his current interests), to environmental conservation and biological diversity (he is a lifelong conservationist), and international cooperation and complex systems (some of the areas supported by the John D. and Catherine T. MacArthur Foundation, of which Gell-Mann is a director). However disparate the subjects of discussion may have appeared at the beginning, the links and connections began to come to light as the conference proceeded. As Gell-Mann concluded, "The emergence of a pattern is the special joy of the theorist."

Paul MacCready (left), creative vehicle inventor, and physicist Valentine Telegdi meet at the conference honoring the 60th birthday of Murray Gell-Mann.

Provost Barclay Kamb opened the conference January 27: "Murray Gell-Mann is vigorously engaged in a search for order and reason in the universe and in nature, from the grand scale of the entire expanding universe to the ultramicroscopic scale of the elementary particles, and with strong attention also to the intermediate scales of our Earth and our lives."

Under the general theme: "Where are our efforts leading?" speakers were asked to reflect on where attempts to meet a particular challenge in science or human affairs currently stand, and also to speculate about how current efforts will look from a future vantage point, and where those attempts will lead in the decades to come. The physicists led off—with topics on the grand scale and the ultramicroscopic scale. (Session chairmen included such renowned physicists as Francis E. Low, Yoichiro Nambu, Yuval Ne'eman, David Pines, Nicholas P. Samios, and Kenneth G. Wilson.)

While the physicists did not shrink from speculating, they were not always in agreement about the future and about the future's assessment of the present. Edward Witten, professor of physics at the Institute for Advanced Study, expressed eloquent confidence that current mysteries are on the brink of solution.

"Our epoch will no doubt be seen as the epoch in which quantum field theory, which was a frail child at birth, full of problems and inconsistencies, came of age, with her frailties and anomalies now seen as signs of strength and beauty, tied up with the natural world. . . . Our epoch will also be seen as a time when quantum field theory, in thus coming of age, has emerged, as perhaps it was not in the past, as a truly fit partner for a faithful match with that other great branch of geometry—Riemannian geometry and general relativity. I hope that our epoch may be seen as an age in which progress in understanding the strong, weak, and electromagnetic interactions led physicists, screaming and kicking though they may have been at first, to become

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From left above: Francis Low, Valentine Telegdi, and Nicola Khuri stroll toward Beckman Auditorium for the Saturday sessions. Below: James Hartle (left) and Edward Witten look over the conference program.

geometers again. It will be seen as an age in which the serendipitous discovery of dual models and the many great discoveries in string theory that followed in the 1970s and 80s, and I hope beyond, have opened gaps in the clouds and enabled us to begin grappling with problems that rightfully should have been reserved for the 21st century. It will be seen as an age in which through these gaps in the clouds we've seen our first glimpses of a wonderful new landscape, which is still largely beyond our imagination. And I think it will be seen as an age in which the visions, the glimpses that we've gotten through the clouds, go well beyond what we can reach with the available tools and in which the search for better geometric understanding is likely to be one of the great engines of progress."

In agreement with Witten on the significance of geometry was Isadore M. Singer, Institute Professor at M.I.T. In his talk on the liaison between mathematics and physics, Singer predicted that mathematicians and physicists will have to "look to the young people for appropriate attitudes. It's still surprising to me how many older physicists think that the only mathematics relevant to physics is what they learned as a graduate student." Singer emphasized in particular how math and physics are related in the study of space and time, noting Witten's recent introduction of topological quantum field theory. "It's hard to believe that ultimately those insights [into new, exotic space-times] will not have some impact on what happened at the Big Bang or what happens in the large in astrophysics." But his predictions for the rest of the 20th century were not quite so sanguine. "Will it be a golden age? For geometry, yes. We will have understood quantum-mechanically as well as classically the nature of three and four dimensions. Application to elementary particle physics? To be seen."

Not all the speakers peered into the future or assessed our own era. T. D. Lee, University Professor at Columbia and a Nobel laureate, presented an elegant effort of his own, which he dedicated to his long friendship with Gell-Mann and which he described as an example of the "mini-maxi principle"—deducing maximum theory from minimum experimental results—at which Gell-Mann is an acknowledged master. Lee addressed himself to a question of how high temperature superconductivity works—do the electrons pair before a material becomes superconducting, or is the creation of electron pairs and superconductivity a simultaneous event? From a comparison of the lattice architectures of high temperature superconducting materials, Lee deduced the latter.

Harald Fritzsch, professor of theoretical physics at the University of Munich, discussed the mystery of the electron mass—why do masses divide particles neatly into three families, and why is the electron so light? Some theorists postulate the existence of a very massive particle, called the Higgs boson, which interacts with other particles to give them their mass. (Witten referred to the Higgs boson as "one of the keys to astronomy and to life.") But Fritzsch thinks that it is very unlikely that the Higgs particle exists. "Personally I believe that things go in a

Yuval Ne'eman (left) and Isadore Singer enjoy drinks and discussion.

different way—that somehow this Higgs particle is just describing something more dynamical; in other words, little things are going on inside, and then we come to a situation where we have not only the nucleons composed of quarks but also the quarks composed of something else—or at least the Higgs particle composed of something else."

In the future, concluded Fritzsch, "new experiments will tell us which way to proceed—not new theories, but new experiments. Nevertheless I think it will still be a long way to the ultimate goal, namely a complete understanding of the particle physics phenomena. Some theorists, including Murray, believe that they are very close to this goal . . . but I think this is not the case. I believe we shall open another gate at the beginning of the nineties full of surprises, but the end of the road is still far beyond our present horizon."

Valentine L. Telegdi, professor of physics at the Eidgenössische Technische Hochschule in Zurich, spoke on the "shelved atom" as an example of the quantum mechanics of nonobservation—"what happens if you don't do something or don't see something." He also predicted that "the next 20 or 30 years will not be some enormous jump forward in particle physics because the energies that we will be getting are not sufficiently different from what we already get now or in the next year or two. But I think that it will be accompanied on the one hand by this weird mathematics that you heard Professor Singer talk about as the thing all young people should know (at which point I was extremely happy not to be a young person), and on the other hand by some anti-Copenhagen sanity recipes, courtesy of Gell-Mann and Hartle."

These "anti-Copenhagen sanity recipes" had been described earlier in the afternoon in a talk on quantum cosmology—the application of quantum physics to the universe as a whole—by James B. Hartle, professor of physics at UC Santa Barbara. Hartle described his and Gell-Mann's search "for a quantum framework that would enable us to erect a fundamental description of the universe on all scales—from the microscopic scales of the elementary particles out to the largest scales of the realm of the galaxies, from the moment of the Big Bang out to the most distant future that we can contemplate. Such a framework is needed if we accept, as we have every reason to do, that at a basic level the laws of physics are quantum mechanical."

Building such a framework will involve discarding "excess baggage," as in the past the idea of a central Earth and the idea of a fixed geometry, which were the consequence of our particular position in the universe, had to be jettisoned to reach a more general and successful viewpoint. Hartle described the Copenhagen interpretations (Bohr, Heisenberg, et al.), which in various ways took "as fundamental the manifest existence of the classical world that we see all about us." But, he went on, "in retrospect, the Copenhagen idea that a classical world or an observer in the act of measurement occupy a fundamentally distinguished place in quantum theory can be seen to be another case of excess baggage. . . . However, these features of the world are not fundamental. Quantum mechanically, the classical world and observers are but one possibility among many and are unlikely to exist at all in the very early universe. They are . . . approximate features of the late universe, arising from a particular quantum state. The classical reality to which we have all become so attached by evolution is but an approximation in an entirely quantum mechanical world made possible by specific initial conditions." Our classical notion of space-time may be another example of ideas that will have to be discarded, Hartle said.

Hartle concluded by expressing the hope "that in the future this might be seen as the time when scientists began to take seriously the idea that it was important for fundamental physics to consider the universe as a whole and science itself as a unity; the time when they began to take seriously the search for a law of how the universe started; the time when they began to work out the implications of this law for science as a

"The gap between the realities of science and technology and the understanding of those realities by our government leaders is growing ever wider."

whole; and the time when we began to discard the remainder of our excess baggage."

The idea of unifying principles, an inspiration from the physicists, carried over to the second day of the conference, which concerned "the intermediate scales of our Earth and our lives."

Unfortunately, the search for unity has been lacking in much of the approach to social problems. John E. Corbally, president of the John D. and Catherine T. MacArthur Foundation, led off the Saturday sessions, noting that "we social scientists seem to delve ever deeper into more isolated aspects of human behavior. . . . There is no unifying principle. Our consideration of education is primarily a consideration of schooling, and we pay little attention to the environments in which both schooling and education take place in the world today. We tend to ignore the chemistry of the brain and the relationship of birth weight and nutrition to that chemistry. We think of motivation primarily in economic terms and ignore the degree to which motivations related to participation in society might be appropriate. We build new schools, and we ignore the alleys in which a great majority of inner-city learning takes place. It's as if we were studying the paths of bodies through the atmosphere without considering the force of gravity."

Former Caltech President Murph Goldberger (left) and current President Tom Everhart compare notes.

We don't have to worry about our analytical abilities, according to Corbally. But "what seems to be lacking are the synthesists who can put back together in meaningful ways what the analysts so gleefully tear apart."

Anthropologist Robert McCormick Adams, secretary of the Smithsonian Institution and former provost of the University of Chicago, also decried the lack of unity in the social sciences. "The social sciences exist today in a condition of vague, frequently contentious paradigmatic pluralism. . . . Some degree of disarray is obviously healthy and unavoidable . . . but what confronts us at present is far beyond this natural and even desirable level of microspecialization and messiness." Because of this splintering, the "important, problem-oriented issues [of our time] are slipping through our analytical nets."

Adams pointed out that, although both social and natural systems are frequently governed by nonlinear dynamics, it is difficult to encompass them in a unified science (such as chaos theory) because social structure and the flow of events in human history are indeterminate. Chaos in a formal sense is deterministic; it obeys mathematical equations.

Some spheres of social activity are, however, fairly orderly and verge on true determinacy, and Adams stressed the place of "both chaotic and indeterminate behavior in the study of human societies. To do so directs attention to instability, fluctuation, stresses and consequent changes beyond tolerable limits and thus to the modes by which human societies have adapted to these difficult-to-identify but ever-present challenges."

The challenges facing global society and the problems of international cooperation occupy the primary place in the MacArthur Foundation's agenda of concerns, and represent its largest single spending program. James M. Furman, the foundation's executive vice president, described this commitment and emphasized how important it is for institutions to find new ways to look at international cooperation in the years ahead. "I'm afraid that too many universities have changed very little in considering international problems of peace and security. . . . The future of international cooperation is tied in large part to how successfully and how rapidly we can bring about institutional change—change in our own institutions and those of others." It will be necessary, concluded Furman, "to address international cooperation with a perspective and understanding that cuts across the single disciplines, the strait-jacketed attitudes reflected in current thinking and practices."

This concept was echoed by Sidney Drell, professor and deputy director of the Stanford Linear Accelerator Center, and until recently codirector of Stanford's Center for International Security and Arms Control, a position he resigned when the university refused to consider for tenure academics working at the center. "The traditional academic structures of many of our

From left: Adele Simmons, incoming president of the MacArthur Foundation, Gell-Mann, Shirley Hufstedler, and Robert Adams applaud the banquet speaker.

great universities are proving highly resistant to the creation of mechanisms for undertaking multidisciplinary work on policy studies in a serious and sustained way," he said. "This applies both to offering resources to support work and to bestowing academic titles, which are the knighthood of the realm, and which are generally reserved for appointment in traditional departments on traditional subjects. I believe strongly in a healthy conservatism in this area in order to maintain rigorous academic standards and to avoid going overboard chasing the latest fashion in policy work. But there comes a point when the process of appointments gets so rigid that innovation is stifled, and the process gets in the way of achieving goals. . . . It is appropriate for universities to uphold the ivory tower from which to peer out over the landscape with widened horizons and a better perspective, the better to anticipate future changes and dangers. But this need not be their exclusive destiny. They can also serve a constructive role in our society by coming down to the ground and entering into the fray of creative, multidisciplinary policy issues challenging today's societies."

Drell and Gell-Mann were charter members of Jason, a group of academic scientists supported by the government to work part time on problems of national importance, particularly the technical ingredients crucial to defense policy decisions. "It was the conviction that we could contribute to sound policy through our technical analyses that motivated our joining Jason and led to further governmental involvements." Looking back on his government work, however, Drell could think of few activities in his life "where the ratio of output to input was so small and the results so frustrating. The gap between the realities of science and technology and the understanding of those realities by our government leaders is growing ever wider. . . ."

The MacArthur Foundation had been crucial to him, Drell said, "in encouraging efforts to work for peace and security through multidisciplinary research and teaching." These kinds of problems involve cultural, behavioral, ethical, and political issues in addition to the technical ones. Such thinking, and a failure of existing institutions to address multidisciplinary issues, led to the founding in 1984 of the Santa Fe Institute, supported financially by the MacArthur Foundation (along with the Department of Energy, the National Science Foundation, Citicorp, and others) and intellectually by Murray Gell-Mann. Another of the day's speakers, George Cowan, gave up his research as a radiochemist at Los Alamos to become president of the Santa Fe Institute because, like Drell, he was "fascinated by what I perceived as a huge and almost unbridgeable gap between facts and policy making."

Cowan interpreted the arena of policy making as encompassing more than security and nuclear war and emphasized that "it's increasingly likely that an exponential erosion of the basic resources essential to human life over a period of relatively few decades will produce catastrophic damage to the structure of modern society. The threat of war may well recede and be overtaken in priority of concern by immediate

Two Nobelists, Abdus Salam and Murray Gell-Mann, discuss a point—of physics or Third World policies.

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dangers." The factors that threaten to produce such a catastrophe, Cowan said, are nearly all related to exponential population growth.

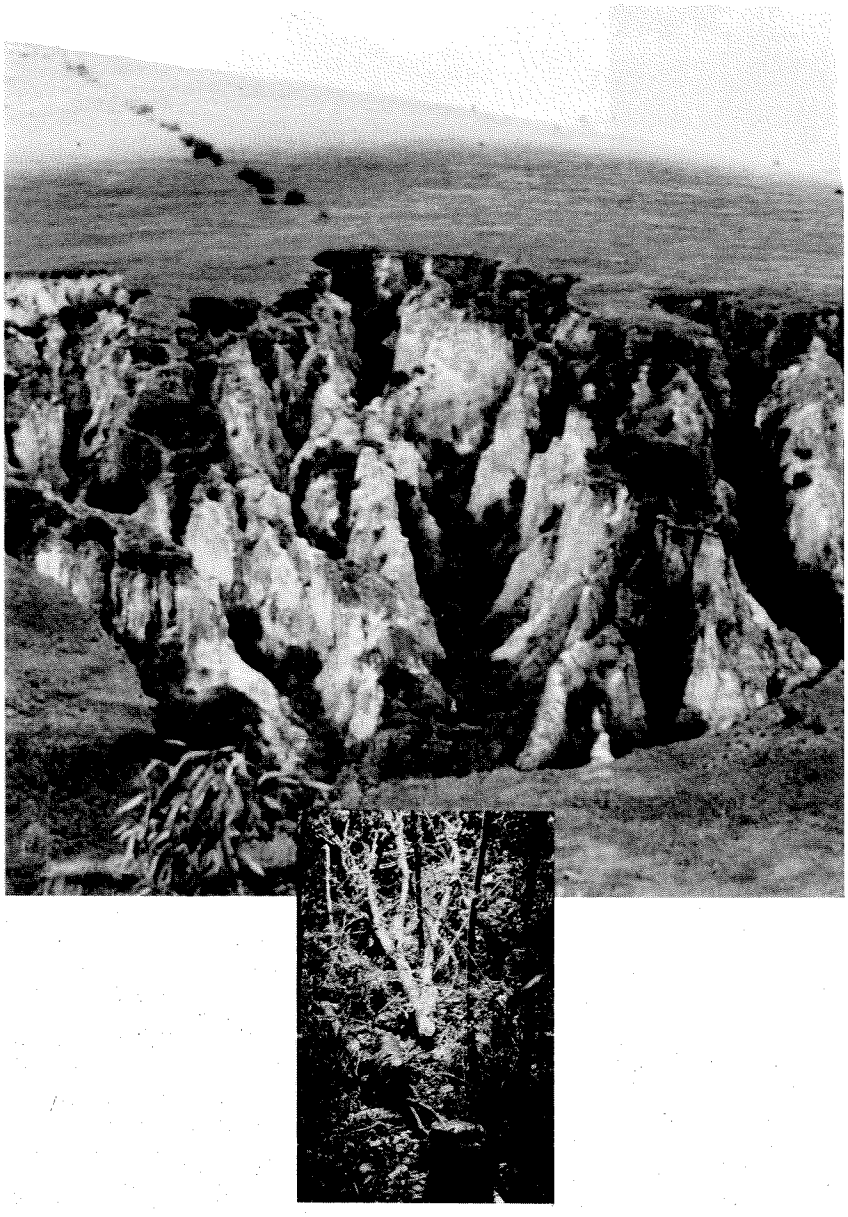
Shirley Hufstedler, Caltech trustee and former secretary of education under President Carter, also emphasized the population problem. "No country, including our own, can manage its economy or maintain sustainable development without addressing . . . the population issues. But that means we must address the issues of women and girls," said Hufstedler. She cited numerous statistics reflecting the soaring birth rate, lack of education, and abysmal reproductive health care of women in poor countries. Family planning does not lack adequate technology; but there needs to be a "distribution of that technology in ways that are culturally acceptable to the women and girls who need it. . . . We should not comfort ourselves that we know how to approach the issues effectively until we do the hard, grass-roots work of understanding the complex systems that have created and maintained those sets of behaviors."

Education, although it does not provide an exact correlation with fertility, is still one of the best indicators for success of population-control programs, said Hufstedler. "The amount of education that girls and women receive influences all their life opportunities. . . . It influences the age of marriage, control over childbearing, paid employment, and access to family planning and health care. Because it is the childbearing aspect of these women that is the most significant in terms of the impact of education, I say that it is even more important to educate these girls and women than their male counterparts."

Abdus Salam, Nobel Prize-winning physicist, and director of the International Center for Theoretical Physics in Trieste, also upheld education as the solution to problems of the Third World —but education in science and technology. The only factor that distinguishes the North from the South, he believes, is "the mastery, the utilization of science and technology." For example, he stated that in his native Pakistan there is a total of 46 PhDs in 19 universities. (Hufstedler's figures noted that only 17 percent of Pakistan's school-age girls are enrolled in school, and that women bear an average of seven children.)

Salam suggested some steps developed countries could take to improve the situation: earmark 10 percent of aid funds for science and technology; support requests (especially to university publishers) for scientific literature; and, through the United Nations, support international centers for science such as the one he directs in Italy.

Science and technology also have a role to play in environmental conservation, according to James Gustave Speth. "Environmental protection must become an affirmative process of redesigning transportation, manufacturing, energy, and housing, so that all of these sectors are more closed and isolated from their impacts on the natural environment. This transformation will challenge science and technology in ways that we can only dimly perceive today." Speth, one of the leaders of the international conservation movement, was formerly chairman of the President's Council on Environmental Quality,

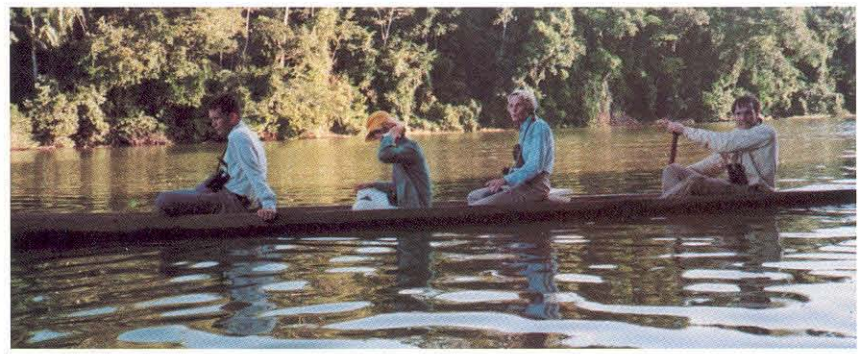


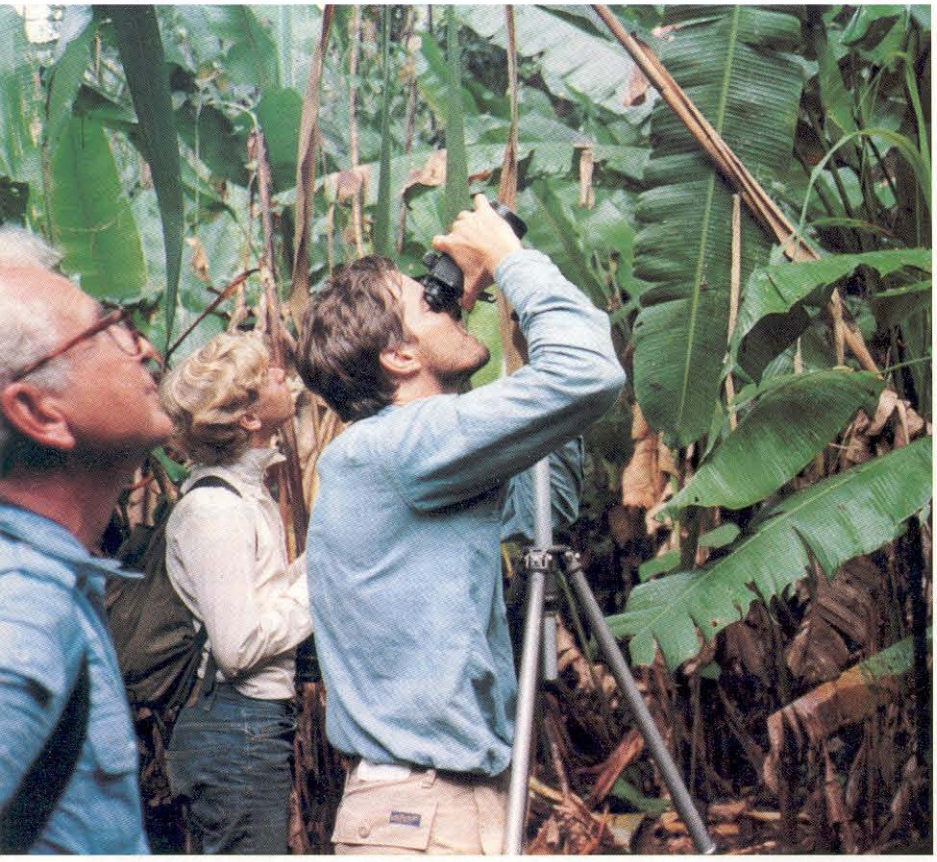
What was once a forest north of Antsirabe in Madagascar is now barren, eroded land, the result of burning. Settlers from Southeast Asia brought the tradition of clearing the land with fire, which is sustainable in an area with more rain and more soil but not here. Timbering (here in the Ranomafana area of Madagascar) is also a danger to survival of the rain forests.

and he is now president of the World Resources Institute, which he and Gell-Mann had worked to "shape and define" together in 1981-82. Another interdisciplinary undertaking supported by the MacArthur Foundation, the World Resources Institute taps the expertise of biologists, physicists, chemists, economists, bankers, businessmen, journalists, former government officials, and experts in environmental policy and Third World development, among others.

Speth was hopeful that "a new and more international environmental agenda is emerging" as political leaders begin to pay attention to these issues. And political leaders are starting to pay attention because this new agenda "affects international economic and political goals—expanding international trade and markets, promoting Third World economic development, and insuring long-term political stability in the world." Speth suggested making conservation a priority mission of international cooperation in the 1990s—an international environmental decade—to deliver a sustained planet as a gift to the new century.

One of the problems Speth noted is that the major debtor countries are also tropical countries and the principal sites of vast global deforestation. He emphasized the importance of a "planetary bargain" that would couple debt relief and wise stewardship of tropical forests. One magnificent and well-preserved area was described by Charles A. Munn, who also had a partial solution to offer for other places. Munn, an associate research zoologist with Wildlife Conservation International, has spent 12 years studying animals in the tropical forests of the Peruvian





A group of tourists (top) explore Peru's Manu National Park by boat. The "world's foremost nature tourist" (above, left) observes birds with Charles Munn in Manu. On the facing page, a cebus monkey, one of the park's inhabitants, forages for a meal.

Amazon, and he brought along slides and a film (giant otters fishing, macaws nesting) of the inhabitants of Manu National Park, where he works. Munn described tropical forests as covering 7 percent of the land surface of the globe but probably housing more than 95 percent of all species of life. "Half of the world's tropical forests have been destroyed just in the last few decades, and the rate of destruction has been increasing."

Munn's suggestion for a solution to the dual problems of vanishing tropical forests and Third World poverty was nature tourism, an undertaking he has promoted in Peru. "Nature tourism is the fastest growing segment of the international tourism market . . . and it could provide more income and employment sustainably for more local people than any other form of economic development." Nature tourism also fosters a two-way education "about the aesthetic and economic value of wilderness and nature. Both tourists and local tour operators experience nature together, sharing viewpoints from vastly different cultures. . . . It should teach both to be better stewards of the natural world." Munn thought his topic particularly appropriate for the occasion "because Murray himself is without doubt the world's foremost nature tourist."

"Murray is a man with his head in the sky and his feet in the mud," was how Peter Seligmann described the same phenomenon. But Seligmann, president of Conservation International, was not as sanguine about solutions to Third World problems. "Creating an inviolate park in a region of the world where social and

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economic crises are acute is foolish. We need solutions to these complex problems, and the solutions have not yet been found. . . . The confluence of today's global problems demands a more strategic, a more experimental philosophy —one that seeks to integrate the elements of an interactive system in which biological diversity and ecological processes are maintained and legitimate human needs are met, and the knowledge of the interdependence of human and natural processes is deepened. This is ecosystem conservation—a philosophy of regional development that unites place and process."

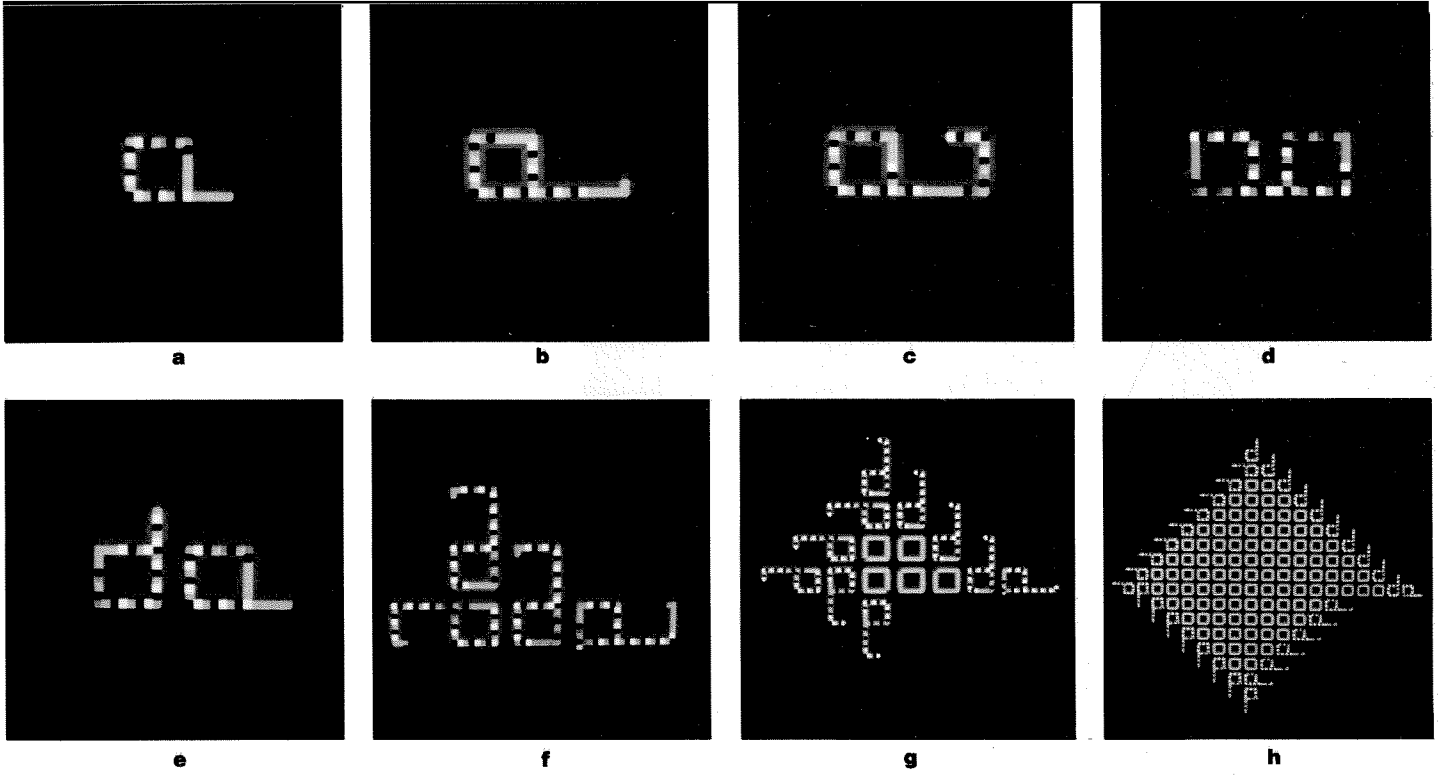
George Cowan also emphasized complex interactions such as those discussed by the conservationists. "If we wish to be effective, we must better understand the coupling between facts, policy making, and human behavior. . . . All of these components and our potential interventions are strongly interactive and influence the behavior of the system as a whole in ways that can't be predicted from intensive research on the individual parts." The decision to found the Santa Fe Institute "to nurture research in the sciences of complexity was stimulated by the obviously growing need for a broader and more coordinated approach to the real problems of society. . . . On questions of global security and conditions necessary for a sustainable world, it's evident that we're dealing with almost the ultimate example of complexity."

Such complex systems are usually nonlinear, said Cowan, and must be examined in their entirety to see their essential properties. Numerical simulation on powerful computers is providing a sort of "intermediate laboratory midway between theory and actual experiment. And in addition, a mathematics of nonlinear dynamics is emerging that is strengthening the theoretical treatment of complexity."

Among the young scientists who have started to create the new sciences of complexity is J. Doyne Farmer, group leader in the theoretical division at Los Alamos National Laboratory and an external professor at the Santa Fe Institute. Farmer described the field of complex systems as one in which "the emphasis is on the nonlinear interactions of simple things . . . on the emergent properties when simple things interact and generate complex behavior."

The most important problem facing scientists in the next 50-100 years, said Farmer, will be understanding "the inexorable tendency for the formation of structure and organization in nature." And one particular approach to that problem is the study of artificial life—"man-made systems that exhibit behaviors characteristic of living systems. . . . It's a pattern in space-time that involves things changing in time—a pattern rather than a material entity in and of itself." The motivation for doing this, said Farmer, is that "if we can actually construct life then we have a hard measure of whether or not we understand something about it. . . . One of the central questions in artificial life is understanding what *is* life."

Farmer showed slides of several computer-generated models (cellular automata) capable of self-reproduction, the formation of colonies, and other remarkably complex behaviors—including



Chris Langton, postdoctoral fellow at Los Alamos, developed this cellular automaton model of self-reproduction. Signals propagating around the "Adam" loop (a) cause the short arm to grow and curl back on itself (b, c, d), producing an offspring loop (e). Each loop then goes on to produce further offspring, which also reproduce (f). This process continues indefinitely, resulting in an expanding colony of loops (g, h), consisting of a "living" reproductive fringe surrounding a growing "dead" core, as in the growth of a coral.

one designed to model "in a very metaphorical way" the behavior of an ant (antomaton). But these just mimic life. "Ultimately the challenges that we face are to produce artificial organisms that spontaneously emerge with no predefined fitness function; that can display the ability of evolution to innovate as well as just optimize; to have genuinely emergent properties that have functional interactions with their environments; that exhibit automatic design without predefined goals; where we see the emergence of organisms with identities. . . ."

Supercomputers will achieve the hardware equivalent of human intelligence by the year 2000, said Farmer, and PCs by 2025. "I think what we're about to see is the ability to make Lamarckian changes in hardware, wherein a conscious organism can actually change the hardware in which another living organism resides. . . . I think that in 100 years we will no longer have a monopoly on intelligence." While he viewed this as a very dangerous thing, he did not consider it bad, but rather "something that could possibly be beautiful," by creating biological diversity. The creation of artificial life, concluded Farmer, is "an inevitability that we can only hope to shape."

A more familiar complex system, the human mind, was discussed by Mardi Horowitz, director of the Program on Conscious and Unconscious Processes at UC San Francisco, another interdisciplinary research facility supported by the MacArthur Foundation. Horowitz discussed the unconscious control of conscious experience related to intrusive thoughts. "What becomes conscious seems to be a concatenation of multiple values and hierarchies decided by an unconscious and very clever control process." This involves schemas (defined roughly by "you can't teach old dogs new tricks"). Using as an example the process of grief, Horowitz described the "reschematization" process of recovery. "It takes time to change the inner cognitive map." Learning more about unconscious thought processes and schemas is important, claimed Horowitz, in understanding values (such as those that lead to the difficulty in changing population growth standards) and how they are transferred between generations.

Horowitz also touched on creativity and suggested the sort of unconscious schemas that make up creative thought. Paul B. MacCready, president of AeroVironment, Inc., also spoke on creativity and thinking skills. MacCready is known for building "peculiar" low-powered vehicles—from the 1977 human-pedaled airplane, the *Gossamer Condor*, to last year's solar-powered *Sunraycer* automobile—"all impractical, but unusual and interesting and valuable as catalysts and symbols to stretch minds," he said. MacCready strongly advocated programs that "give the tools . . . to perceive openly, to operate from a broad perspective and healthy skepticism, and to process information creatively." He claimed to be "a fair pessimist about civilization's future," agreeing with Farmer that surviving life may well be not carbon-based at all—but rather silicon- or gallium-arsenide-based.

John H. Schwarz, professor of theoretical physics and co-organizer of the conference,

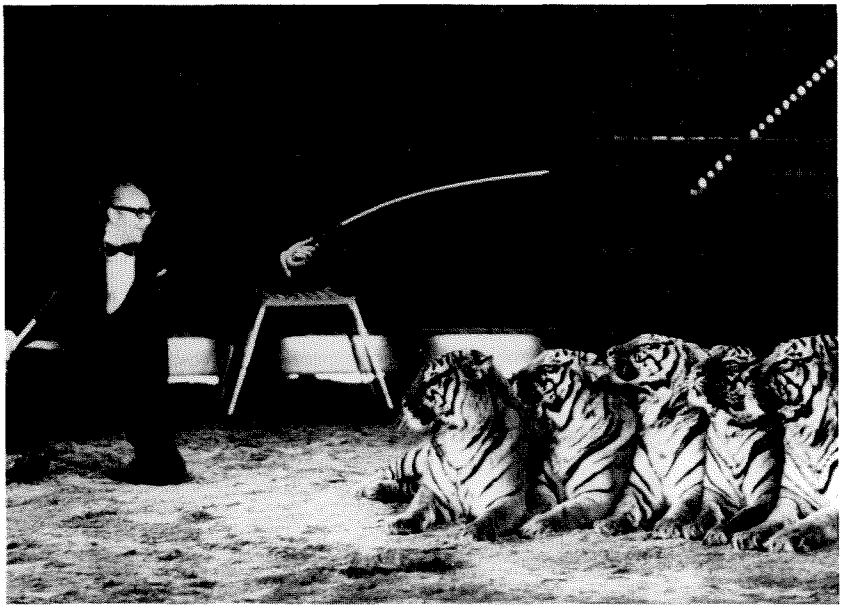
Most of the participants couldn't resist taking the occasion of "celebrating 60 years of Murray Gell-Mann" to make some good-natured fun of his well-known extracurricular interests—languages and birds in particular—and of the occasion itself. Telegdi pointed out that since Gell-Mann's birthday is in September, the conference must really be commemorating the 60th anniversary of his conception. Nicholas Samios, director of the Brookhaven National Laboratory, remarked that it was characteristic of Gell-Mann to reach 60 faster than anyone else. And Nobel laureate Kenneth Wilson, professor of physics at Ohio State, speculated that Gell-Mann's early start in physics was due to his childhood realization that he had been born 10 billion years too late to observe the Big Bang and didn't want to miss anything more.

Although birds belonged perhaps more aptly to the second day of the conference, tales of Swiss birds, Israeli birds, etc., crept into the physics sessions as well; Telegdi entitled his talk "Is Quantum Mechanics for the Birds?"

Gell-Mann's rigorous attention to correct pronunciation (in many languages) came in for some ribbing. Corbally confessed to always waiting until Gell-Mann left the room before attempting to pronounce any foreign word. Seligmann informed the guest of honor that "my father tells me I *am* pronouncing my last name correctly." And more than one speaker described being suddenly hailed at some foreign airport in impeccable idiomatic Mandarin (or Hebrew, or . . .) with the subsequent discovery that the hailer was, of course, Murray Gell-Mann. But Marvin Goldberger, director of the Institute for Advanced Study and former president of Caltech, recalled stories of less-than-dazzled Chinatown waiters and unimpressed fishermen on the Isle of Skye (where Gell-Mann attempted some Gaelic). At the closing banquet Goldberger delivered his birthday greetings in Fang, a Bantu language spoken in western equatorial Africa, and Nicola Khuri, professor of physics at Rockefeller University, opened his remarks in Kurdish.

Telegdi offered a dubious etymology of the honoree's name, and showed some doctored slides of Gell-Mann as the true Renaissance man—as orchestra conductor, chef, acrobat, fencer, and tamer of tigers.

Taming tigers — requirement for a Renaissance man.



attempted in its waning moments to portray Gell-Mann's accomplishments by listing (just for fun) all the physics terms he had introduced—from "quarks" to "strangeness" to "gluons." But MacCready, who had also attempted to describe Gell-Mann's contributions, concluded that, "Murray Gell-Mann can only be characterized by two days of talks by friends from around the world." □ — *JD*

The conference proceedings will be published by Cambridge University Press.