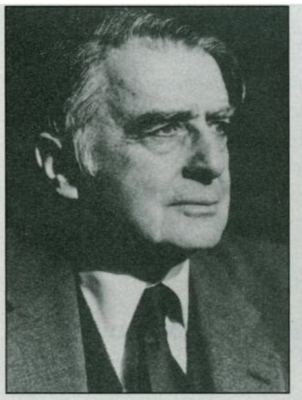
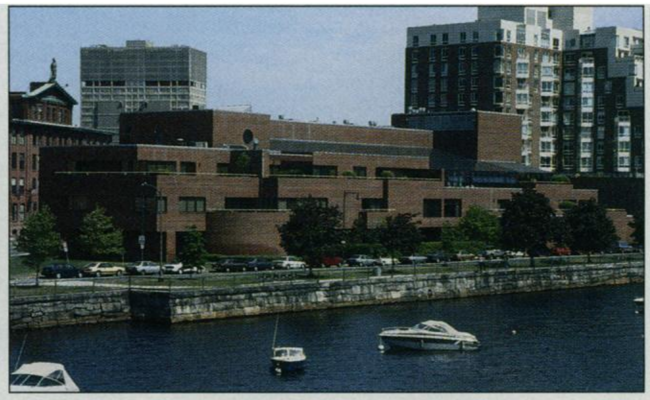
INSTITUTIONAL PROFILE

The Rowland Institute for Science: Land's Last Experiment





A man and his plan. Edwin H. Land, the late polymath scientist and inventor, founded the Rowland Institute for Science in 1980. Inside the building, which faces the Charles River in Cambridge, Massachusetts, researchers from diverse disciplines can mingle in a Japanese garden.

Near the Cambridge side of the Longfellow Bridge, which links Cambridge to downtown Boston across the Charles River, stands a sleek and handsome brick building. Nothing on the outside—except, perhaps, a cylinder of liquid nitrogen in a delivery bay—hints at what goes on within. It takes some squinting even to find a nameplate. Inside, no receptionist greets a visitor; there's just a security guard in a glass booth, checking names against a clipboard.

The Rowland Institute for Science, in the self-confident tradition of exclusive clubs, feels no need to advertise its existence. Until now, it has never allowed journalists more than a cursory glimpse before showing them the door. And in keeping with the understated exterior, the interior is a place of privilege—at least as scientists define privilege. The Rowland's 30 or so scientists don't worry about getting grants to fund research. They don't pray for tenure, scrounge for equipment and lab space, or attend content-free meetings. Even publishing papers—which they do in abundance—is an option, not a requirement. Working there, says organic chemist James Foley, a Rowland Institute researcher, "is like going to heaven without dying. It's what every scientist dreams about."

Foley's heaven is actually a bold and idiosyncratic experiment, one whose outcome is still uncertain. The Rowland Institute embodies the way the late Edwin H. Land—Harvard dropout, inventor of instant photography, founder and research head of the Polaroid Corp. until his departure in 1982, and holder of 537 patents—thought research ought to be done. Not one to leave exciting ideas untested, in 1980 Land founded the Rowland Institute (he allegedly never explained the origin of the name), earmarking an endowment that in 1990 amounted to about $54 million, according to tax forms. He then set about recruiting a small, wildly diverse group of researchers for what amounts to indefinite fellowships, in which they work virtually unfettered by worldly concerns. "Land's thought was that scientists should be free to do science and they shouldn't have to worry about all of the other stuff," says Rowland biophysicist Steven Block, who also holds an appointment at Harvard University.

The result was an insular place where a cadre of diverse scientists, including the polymath Land himself, could work unhindered. "The only limitation here is your imagination," remarks Block. It's sort of like Bell Labs in its heyday, when researchers were encouraged to do nothing more than follow their noses, says Stanford University physicist Stephen Chu, who has visited the Rowland Institute twice. Rowland staffers and other observers, straining for comparisons, liken the Cambridge research haven to the Institute for Advanced Study at Princeton, the Basel Institute for Immunology, the nearby Whitehead Institute, and other places where well-funded researchers work under a minimum of bureaucracy. But unlike those more specialized outfits, the Rowland Institute doesn't respect disciplinary or methodological boundaries. Like a scientific Noah's Ark, it houses an example or two of research in a dazzling diversity of basic sciences. The contents of this ark, however, were chosen not for completeness, but in many cases simply because they caught Land's fancy.

That freewheeling approach to science has already had some impressive payoffs, not in the form of knockout inventions like instant photography, but in the kind of basic research that could presage them (see sidebar). Still, Chu suggests that "its strength could end up being its weakness." The womb-like atmosphere of the Rowland frees the researchers to concentrate on research and ensures a degree of cross-fertilization unknown at academic institutions, he points out. But he wonders if the small, somewhat isolated staff, like an undersized breeding population, also makes the Rowland vulnerable to "a certain sterility."

It's simply too early to say how the obvious advantages of Land's approach and its potential drawbacks will balance out. For now, "we are in a period of transition," says Philip DuBois, Land's son-in-law and a part-time physicist who now spends several days per week at the Rowland taking care of day-to-day business and managing the more than $5 million per year that he says it takes to run the place. The essence of the transition, Rowland members say, is the loss of their father figure with Land's death 15 months ago.

When Land was living, Rowland staffers say, he seemed to be everywhere all of the time, forever interested in both the big picture and the minutiae of his experiment, down to the flowers in the expansive interior Japanese garden, where Foley and other members stroll and contemplate problems. "It was Edwin Land's private sandbox," remarks Chu of Stanford. During a lunch gathering in May under a vaulted skylit ceiling, flanked by a greenhouse and overlooking the Charles River, Rowland staffers told *Science* that they remember Land as a mentor and patron whose premier concern was to help them live up to his single, inherently subjective criterion, which members recite as a credo—"to do work that is manifestly important and nearly impossible."

Besides setting the tone, Land made virtually all the decisions, handpicking the staff and parceling out funds. "Now we have to be grownups," remarks Block, who has been at the Rowland since 1987 developing laser-based optical tweezers for manipulating individual cells or parts of cells. "We're on our own without this guy." Without him, the Rowland Institute's modus operandi has had to shift from one in which virtually every action was overseen by a single visionary to one of collegial, collective governance. When a decision has to be made, say, about hiring a new member (though DuBois points out that the staff is at or near its limit), a new research proposal, or buying an expensive laser—decisions Land used to make—members simply gather as equals, discuss the matter, and make recommendations to DuBois and the rest of the board, all members of Land's family. That's the bureaucracy at the Rowland Institute.

That's also more bureaucracy than researchers ever had to cope with under Land. But director DuBois tries to keep it to a minimum. "I feel guilty every time I ask someone to serve on a committee," he says. For now DuBois says his job is to "reassure the members that the Land family is dedicated to keeping this place the way Land wanted it...indefinitely."

A Scientific Spice Bowl

Inside the Rowland Institute, a potpourri of scientific backgrounds and experimental skills coexist in an environment meant to mix them in unpredictable ways. The research staff ranges from physicists through chemists and biologists to computer scientists. There's even a philosopher on hand. What they have in common is the drive to ask fundamental questions and the temperament to seek answers in an unstructured environment. Some, like Foley, came from Polaroid at Land's beckoning, trading the pursuit of better products for basic research. Others, like philosopher of mind Neil Malcolm, approached Land themselves and ended up with offers from him. Craig Shaefer, an organic chemist-cum-computer scientist who in 1981 interviewed with a recruiter from Polaroid on a lark as a Harvard University graduate student, ended up getting a call from Land and ultimately an offer to work at the Rowland Institute, which Land had just founded. Several "outside members" have primary appointments at Harvard but were invited by Land to do research at the Rowland. Still others came at the beckoning of existing members as postdocs, graduate students, or collaborators, sometimes landing a full-time position.

Their house of research is a striking brick building whose open bright spaces invite members out of their offices and well-equipped laboratories, fostering encounters that would be rare at larger and more compartmentalized institutions. While strolling in the Japanese garden, psychophysicist Robert Savoy, who aims to uncover how certain bizarre effects in visual perception might be windows into previously unrecognized brands of learning, can discuss his work with cluster physicist Joel Parks, who investigates with collaborator Stephen McDonald how atoms accrete into clusters on their way toward forming solid materials. During lunch, computer scientist and "artificial life" investigator Stewart Wilson might describe his animal-like computer programs (animats), which learn to satisfy their own needs within the constraints of simulated environments; in return he might hear about the challenges confronting molecular scientists striving to learn how proteins fold into biologically functional shapes.

Often, say members, such exchanges result in nothing more than mutual enlightenment. But sometimes this eclectic mix has yielded surprises. In 1987, while watching Block manipulate bacteria with optical tweezers, solid state physicist Jene Golovchenko

The Freedom to Follow Your Nose

What happens when you free scientists from the entanglements of bureaucracy or the endless travails of grantsmanship and send them out to play? That's what Edwin Land wondered when he recruited a handful of scientists from a dizzying range of disciplines to the Rowland Institute for Science in Cambridge, Massachusetts, and promised them indefinite support to ask high-risk questions (see main text). Although there is as yet no clear verdict on the success of the approach, the institute has nurtured some lines of research that are pointing to surprising practical and scientific payoffs.

■ **Developing anticancer agents.** When Land invited James Foley to the institute in 1982, it wasn't easy for the physical organic chemist to leave the nearby Polaroid Corp., where he had worked since 1969 developing dye molecules. Still, Foley had a yen to do basic research; at Polaroid, he recalls, "we were always putting out brush fires and seldom had time to sit down and really figure out how things work." Now he has the freedom, even the mandate, to do just that. He has been modifying the molecular structure of certain dye molecules, hoping to improve their efficiency at harnessing light energy to form highly reactive oxygen radicals. And that basic research may come full circle to potential applications, in the form of photodynamic cancer agents—molecules that, when activated by light, could unleash oxygen radicals to destroy malignant tissue. With collaborators at the Massachusetts General Hospital and Harvard Medical School, Foley has been trying to remodel the molecular structure of the dye known as Nile Blue A, which has the surprising property of selectively infiltrating tumor cells, to turn it into an agent capable of killing cancer cells when activated by light.

■ **Exploring quantum-classical borderlands.** To Lene Hau, "if you want to do new physics like we are doing, [the Rowland Institute] is the ideal place. You are supported by a system that can move fast. You don't have to wait a year for grant approval." In the laboratory she shares with Jene Golovchenko and Michael Burns, brilliant stippled ribbons of yellow and green light wend through a maze of lenses, mirrors, sensors, calibrators, and other devices. Split into twins and triplets and then steered from several opposing directions into an ultrahigh vacuum chamber, the beams impinge on jiggling sodium ions, which respond by shedding photons of their own. The balance of intake and output ends up cooling the ions to microkelvin temperatures, mere millionths of a degree above absolute zero.

That ultra-stillness, Hau explains, enables her team to make some of the cleanest possible measurements of fundamental physical constants. And because the atoms can be pinned down so precisely, they can be poised right at the boundary between quantum-mechanical behavior (in which atoms jump from state to state) and classical behavior (in which their state changes continuously). In the 1 May *Physical Review* A, Hau, Golovchenko, and Burns present a scheme for doing so, which they are now testing: Cool the atoms in the vicinity of a thin conducting wire charged with small voltages that vary at high frequencies. Providing the atoms can be electrically polarized, they will be locked in orbit around the wire, vacillating between being attracted toward it and straying from it.

This puts the atoms just where the physicists want them. "Just by tuning the voltage [on the wire], we can choose between quantum mechanical and classical regimes," Hau notes. In the classical regime, the energy of the atomic orbits around the wire got the idea of trying to manhandle nonmetallic spheres with light. Along with Michael Burns and Jean-Marc Fournier, Golovchenko was startled to find that the lasers, besides pinning the beads in place, induce attractive forces between them, arraying the beads in crystal-like patterns. Such "optical matter," which the researchers first reported in September 1989, might prove useful one day for processing materials by preorganizing tiny polymer or ceramic particles before they are bonded more permanently.

Is Land's Experiment Working?

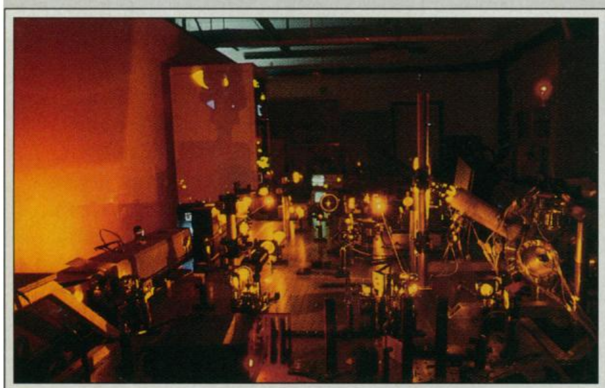
In spite of the opportunities for cross-fertilization within the Rowland Institute, some of its members end up feeling estranged from colleagues in their own fields. When each member represents all or half of a particular department, remarks cluster physicist and surface scientist Stephen McDonald, "there is no concentration in your own field and so you miss that specialized ferment" bubbling in many university, industrial, and government research settings. Outside professional commitments such as journal editorships, which might help some Rowland members enter those ferments, don't fit into the Rowland vision of research unencumbered by worldly concerns, notes computer scientist Wilson. He reluctantly decided to turn down the editorship of a journal called *Adaptive Behavior*, premiering this summer. "It is not sufficiently appreciated [here] how important outside connections are," he feels.

Block points out that any intellectual fellowship lacking at the Rowland Institute is easy to find elsewhere in the Boston area. With places like Harvard University and MIT a few subway stops away and high-tech companies like Thinking Machines Corp. literally across the street, the location picks up the slack. But Block admits that "this place would not have worked if it were somewhere in the middle of Kansas."

For the most part members are as concerned with maintaining the Rowland Institute's own sense of identity as they are with building bridges to outside researchers. In the absence of Land, who served as the human hub anchoring the Rowland's otherwise divergent research interests, it has become a capable orchestra playing smoothly, if sadly, without its former conductor. Last month, for the first time, Rowland members gathered for an annual review in which each member reported his progress and plans, an exercise that DuBois says was intended to foster a crisper sense of collective identity. Nobody, including DuBois by his own admission, knows quite what to expect as the Rowland heads toward the next century.

Even assuming that the Rowland Institute succeeds as measured by the quality of science that its members produce, it won't be an easy experiment to replicate. "You can't just transfer what we learn here to somewhere else," says Burns. For one, deep-pocketed visionaries like Edwin Land aren't exactly lining up to endow their own Rowland Institutes. And with university budgets facing a tight squeeze and basic research being cut in industrial research laboratories, any pockets of freedom and security like that found at the Rowland Institute are likely to become scarcer, if anything. But even if Land's experiment can't be replicated in every detail, Burns thinks, parts of it might be. The Rowland's message, he says, is not likely to be "do it the way we do it," but rather to use the Rowland Institute's model of minimal bureaucracy, cross-fertilization, and faith in self-motivated researchers wherever it might fit in. If those tactics succeed at the Rowland Institute, Land will have posthumously completed an experiment at least as important as any in his institute's laboratories.

–Ivan Amato



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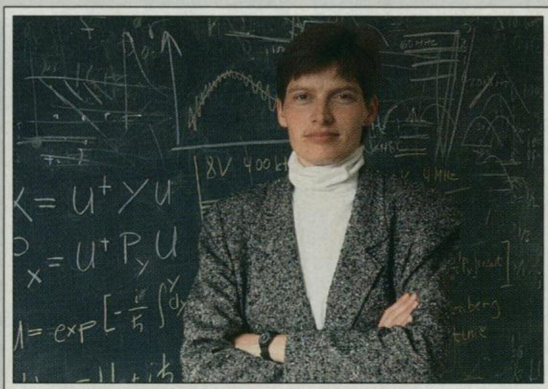

J.J. SCARPETTI

Stilling the atomic dance. Lene Hau and collaborators thread lasers through a busy optical bench on their way into a vacuum chamber, where they bring atoms to a virtual standstill.

would vary continuously with changes in the wire voltage; in the quantum regime the orbital energies would jump between distinct levels. Being able to toggle between the two realms could give physicists an unprecedented window on the boundary between these seemingly contrary continents of physics.

■ **A new approach to artificial intelligence.** When computer scientist Craig Shaefer accepted a job at the Rowland Institute, he was completing his graduate studies at Harvard University with the world-renowned organic chemist Robert B. Woodward. But once at the Rowland Institute, far from bureaucracies and tenure tracks, Shaefer felt free to make a major shift—to computer science. With his collaborator John Bergsma, Shaefer is trying to fulfill some of the unmet expectations of artificial intelligence research.

"In the 1960s computer scientists told us that computers were going to sit in our laps and talk to us," Shaefer says. "That never came to pass." In response, Shaefer has been developing what he calls a "new learning system that solves problems in a way modeled on how science does." In essence, Shaefer's system tries out many different strategies for solving a given problem—determining the most stable configuration of a molecule, say, or the best route for a salesman visiting 100 cities. The program assesses the efficiency of each approach, then modifies, mixes, and matches the methods to come up with better ones, even ones human researchers might not have thought of. In theory, the program, which Shaefer calls ARGOT (a merciful acronym for Adaptive Representation Genetic Optimizer Technique) and is still under development, should guide scientists to faster answers or toward new problem-solving strategies when existing ones run out of steam.

Those and other projects under way in the Rowland Institute's laboratories suggest that whether or not the institute succeeds as a grand experiment in how to do research, it is bound to emerge from what until now has been its well-cultivated obscurity.

–I.A.