PHYSICISTS WITH UNUSUAL CAREERS

The experiences of seven young physicists may be relevant for their colleagues who are looking for jobs as well as for the future of physics.

Marian S. Rothenberg

PHYSICISTS are usually found working in physics laboratories and teaching in physics departments. But there are now, and probably always have been, people who complete their education in physics but pursue careers outside these traditional areas. And they are happy in these jobs.

We thought that now, when opportunities in traditional physics have been continuing to decrease, would be a good time to talk to some young physicists with unusual jobs. Why did these people choose to study physics, and why have they changed direction? Are they special kinds of people, or can some other young physicists, disheartened by their failure to find jobs, profit by their example?

Many well-known physicists have branched out into other fields, often on a part-time basis. But we were interested in young people who had no established reputations of their own to trade on and have managed to support themselves by working, full time, at a job outside the narrow limits of traditional physics. I interviewed seven of these young physicists. These had not been inferior students; on the contrary they are bright and possess respectable (in some cases outstanding) academic credentials. Although some of them originally took their jobs because they could not find exactly what they were looking for in teaching or in research, they are all now quite enthusiastic about what they are doing. Some like being closer to the "real" world; others like the degree of independence they have in their work; others are disillusioned with physics as a discipline and find the content of their new speciality to be much more interesting.

Our subjects had chosen to study physics for a variety of reasons. One was "curious about how nature works," another said that "the cleanness of the analysis involved" in physical science appealed to him. Should this educational choice limit someone to a career inside physics, or what we have chosen to call physics? Training a person's mind through physics suits him for other jobs as well, and perhaps other specialities could benefit from the full-time attention of a physicist.

The people we spoke with still consider themselves physicists. Five of the seven continue to be members of the American Physical Society, and all feel that their background in physics has shaped their approach to problems. Most are considered physicists by the people with whom they work. Perhaps we should be redefining physics.

There is a message here for young physicists who are disillusioned with their subject or with their employment prospects; if they combine the "cultural background" that physics gives them with some special qualities or interests of their own, they might enjoy the results. This gives us a clue to what physics will mean in the years to come; its definition may be broadened as physicists turn their attention more and more to world problems. An immediate crisis could then turn out to be an advantage in the long run.

Marian S. Rothenberg is an associate editor with PHYSICS TODAY.

Air–traffic control

Stuart Starr, who got his PhD at the University of Illinois in plasma physics, is quite enthusiastic about his work at MITRE Corp in McLean, Va., where he applies up-to-date statistical techniques to the control of air traffic. In his doctoral work in plasma physics, Starr tried to predict the radiation that would emanate from a plasma as a result of applying force fields. He was bothered by his realization that any analysis he did had to be very restricted (because of the complex nature of the plasma and the nonlinearity of the equations) and felt that, to a large extent, it was all an academic exercise. ". . . After a while, it feels like a constricting force . . ., and I was getting very disturbed about doing work that was constricting me and isolating me from the world."

He became interested in working for MITRE through an employment interview (instigated by the company) at the Illinois campus. Application of analytic techniques to traffic control interested Starr, and he discussed his ideas (based somewhat on the ideas of I. Prigogine) with this recruiter as well as with subsequent MITRE interviewers. They offered him a job, and he accepted.

When he arrived at McLean, he tried to apply, rather directly, the kind of sophisticated many-body techniques he'd previously used to his present job—control of a long line of planes. A typical problem might be: Suppose you (a traffic controller) want to ensure that the order of an aircraft convoy is not disturbed because of such effects as environmental forces or the behavior of individual pilots. What should be your basic strategy for issuing commands to the aircraft, and how should you implement this strategy? The situation seemed analogous to a dilute solution on which order must be imposed.

His techniques, however, turned out to be not quite appropriate to the problem; he couldn't apply them to a dynamic situation. Through conversations with others—electrical engineers, for example and, particularly a control theorist that MITRE subse-

"My background in physics and math has made it relatively easy for me to read the papers and understand what was going on."

Neurophysiology

John Sunderland, who works in neurophysiology and artificial intelligence at Rockefeller University, has switched to biology from experimental high-energy physics. He finds biology "linguistically more accessible—you don't have to prepare yourself as long to think about the interesting things." He has had an interest in biology for many years, although he completed a PhD in high-energy physics. As an undergraduate at Columbia College, he was a premedical student and a chemistry major before settling into the physics department. When he began graduate school at Columbia, Sunderland's interests were in particle physics.

Sunderland had occasional thoughts about switching into biology while in graduate school. He was told, at one point, that his dissatisfaction might be with graduate school in general rather than with physics, and that he would be better off if he finished his degree in physics. He stayed on in physics, accepted a postdoc at Columbia, and he didn't think too much about biology. He *did* attend biology seminars that Samuel Devons of Columbia had organized for people in the physical sciences, and he participated in a biophysics class.

"When I joined the Yale physics department, I had more time to think. Although I was experiencing reasonable success with my work, it became clear to me that I didn't want to do this forever." Sunderland saw an announcement for a Varenna, Italy summer school in pattern recognition. Devons encouraged him to attend, and, when he returned, Sunderland was more certain that he wanted to get into biology. But then, says Sunderland, "it came down to exactly what I would like to do. I did not become a biologist the same way I became a physicist; I looked to see what I could bring to bear on a particular problem." This definition of one's interests, he says, is something that graduate school hardly ever requires of you.

After he had presented research proposals to several groups with whom he thought work might be mutually profitable, Sunderland decided on Rockefeller. "Here we work in small groups and can maintain an independence of interest." Sunderland is studying the ways in which the nervous system processes information. Organization of the input side, or receptor physiology, particularly interests him. The experimental work that he does has so far been on the eye of a horseshoe crab; this eye is an example of a simple receptor system. By following various light-induced signals through this neural system, Sunderland not only learns about the crab's eye, but can also generalize his results to other neural systems.

His coworkers, says Sunderland, are "think-oriented rather than work-oriented. There is no pressure here to produce rapid results." Sunderland spends a good deal of his time reading in related disciplines. "I've only been here a few months and am still in the process of redefining my interests."

What is it that he likes in biology? "In biology you can learn by doing rather than by studying." He contrasts this with the case of general relativity, in which a person may quently hired—Starr became aware of other techniques. As he says "the type of background I have in physics and math has made it relatively easy for me to read the papers and understand what was going on."

He found it crucial, in this problem, to recognize that one has only partial observations of the system he is trying to control. Control-theory techniques use this limited data to make a best estimate of the other significant variables; they then issue the "best" commands for the control of the aircraft convoy.

The aim of this work is to design a satellite to monitor North Atlantic air traffic. Starr and Barry Horowitz, the control theorist, are looking for the best possible commands to regulate the planes, to keep them on their tracks and the best possible distance apart so as to derive maximal economic benefits from the limited capacity of the skies. Says Starr, "Invariably (one) has to sacrifice mathematical sophistication for the ability to cope with the really important things. We've got techniques we feel don't compromise the important things."

Physics helps him in a more general way than through the specific techniques it enables him to master. It teaches you, Starr says, how to stratify a problem, to determine what the significant variables are; in other words, it makes you rational. From this point of view, he believes, the problems he's working on now are much harder than those he dealt with in plasma physics. He is in a situation where he has no feeling for what the constraints are, where he must find out himself what's important.

Initial computer simulations have been done, and Starr and his colleague now have a product. But they must convince the Federal Aviation Administration that they have a real understanding of the problem. It's not like being at a physics convention, says Starr, where people can finish half the sentences that you begin because they know where things are leading. "You're very much dependent on being able to sell ideas." For examples he tells them "You've now got planes separated by 120 miles longitudinal; with our techniques, you can separate them by much less and retain the same level of safety." Technical competence isn't enough to let you sell anything, and this requirement, Starr finds, is challenging and enjoyable.

The job at MITRE was not the only position open to Starr when he received his degree. He had several offers closer to physics. But Starr, who had been a Phi Beta Kappa student at Queens College, New York before he transferred to Columbia to finish up in their engineering program, had always been interested in the humanities, and nearly became a history major. He finally chose to reject history for physical science at least partly, he says, "... because of the cleanness of the analysis involved."

He has been influenced by Norbert Wiener's *The Human Use of Human Beings*. "I want to be what I consider a first-rate individual in what I'm involved in. And I felt that to approach that in physics would require so much out of me it would make me a second-class person. If you feel you're really competent, you might want to get into something where you can be grade one, and I feel that the urban field offers such opportunities now for a person who has both training in physics and a desire to work on social problems."

---

spend most of his career orienting himself.

Sunderland also likes the idea of working on his own. In high-energy physics, on the other hand, you often need the cooperation of several specialists to do an experiment. High-energy physics means a long-term commitment, because of the people and the hardware involved in an experiment. "You often can't change tack in the middle of an experiment, although you decide you are no longer interested in its results." Sunderland likes the freedom he has to work in more places, because biology needs less hardware. "Accelerator centers often have a science-factory atmosphere," he believes.

The "cultural background" that physics gives him is valuable to his work. "I am comfortable with math and technology; I neither fear them nor regard them as a magical cure. I feel a physicist can often better judge whether or not one can get more information from a given experiment by developing it quantitatively. The ability to look at things in an analytic way can be brought to bear in fields other than science."

"I did not become a biologist the same way I became a physicist; I looked to see what I could bring to bear on a particular problem."

Computer–liaison

Charlotte Hollister works for Bolt Beranek and Newman, a research, development and consulting company located in Cambridge, Mass., where she is helping design a central computing facility for research pharmacologists. Her training is in chemical physics; she was a chemistry major at Vassar College as an undergraduate, did her PhD at Yale University and had a postdoc at New York University. Hollister considers that her background has been useful to her several ways and that she is better suited to the work she is now doing than to the teaching career she had originally envisioned for herself.

BBN has a government contract, from the National Institutes of Health, to design a system that will enable pharmacologists to store results of the drug tests they perform. It had been decided, before Hollister started working for BBN, that the computer system would have graphics terminals. They would have a cathode-ray display rather than the more usual teletype, because it is difficult to represent organic molecules any other way.

Developing a computer system that can handle the chemical structures is the task that interests BBN. Hollister talks to pharmacologists to determine what kinds of work they do and what their needs, in terms of a computer system, would be. She has also been designing the high-level language that the individual user will use to talk to the computer.

Pharmacologists, it turns out, hardly use computers at all and, says Hollister, they "are somewhat resistant to learning a program language, like Fortran." In addition, many of these languages are not particularly well suited to the requirements of pharmacologists, who may synthesize hundreds of compounds, all analogs of a given drug, and test them. "They don't need a particularly quantitative system; they want to know whether or not there is a response to a drug and not exactly how much of a response there is." Hollister decided to store the data in tables, which is the way the pharmacologists store it.

Hollister's education, although officially in chemistry departments, has had very little to do with organic chemistry. But she understands the way people who do research report their results—what the various numbers mean and what the spectra look

". . . it's more a matter of methodology and ways of thinking than actual knowledge about one thing or another."

PHOTO BY ROSEMARY GAFFNEY

Science writing

Michael Wolff is a senior editor for *Innovation* magazine. He has a master's degree in physics (from Adelphi University, New York) but, he says, "I was always interested in science and in writing. If you're interested in two things and you can't choose between them, then what do you do? You try to combine them."

In college he studied physics, Wolff says, simply because he found it interesting. "I wanted to learn, in a fundamental way, how nature works. I was a boy chemist who did experiments at home, like in the comics. In

"If you're interested in two things and you can't choose between them, then what do you do? You try to combine them."

like. She knows how much basic information there is in a given paper, and so knows how careful the programming must be to make the information useful when it is retrieved. "It's more a matter of methodology and ways of thinking than actual knowledge about one thing or another. If I do a little reading before each visit, it's usually enough so that I can ask intelligent questions." She is also aware of the kinds of routine computations that pharmacologists must do and have difficulty with, such as plotting least squares and calculating molecular weights, and is trying to include these standard computations into the language.

Most of her time, she says, is spent designing the language. A good deal of her work as a postdoc involved the adaptation of various Fortran programs to her own needs, so she is on somewhat familiar ground. "From the point of view of the pharmacologists, I'm a computer expert, and when I talk to the people here, I'm a chemistry expert. It's the greatest set up I ever saw."

Hollister's original goal was to teach and do research at a university. She could not, however, find a satisfactory academic job, and so answered the employment advertisement in *Science* magazine that led her to BBN. Now that she is in it, she finds her work just as interesting and less frustrating than what she was doing before: "I could see what you had to do to get your name known and your papers referred to. The best thing was to do absolutely the most accurate calculation you could on the biggest molecule you could manage. And while I thought it was useful, I didn't think it was all that exciting. I just didn't feel I was making any contribution that depended on myself as opposed to n other people. And while programming is fun, it's like doing a crossword puzzle, it's not the sort of thing I like to spend a lot of time doing. The whole job just suits my capabilities and my temperament a lot better than what I could see I was getting into."

Nor has Hollister given up the idea of doing some teaching. BBN has a small education program, and she is busy promoting a semester course that she could teach while working for them. To her surprise Hollister found that "one of the things that's considered a viable activity around here is sitting around thinking of things to do. If you can think up a project and get support for it, then that's fine." All in all, she says, "I'm pretty satisfied with the way it's worked out."

---

college, however, I found that real chemistry was like cooking, so I became a physics major."

But, Wolff continues, "I should point out that it seemed to me in college that I was not going to be a genius physicist. And it was also made quite clear to me that physics was not interested in you unless you were planning a PhD in physics and were really willing to concentrate 100% of your life on it. In that way physics is a snobby profession." Wolff tells how his college adviser berated him for spending so much of his time (30–40 hours per week) working for the college newspaper. "He said that I shouldn't be wasting so much time on it. He was very offended that I was spending so much time on something as trivial as journalism."

When Wolff was graduated from college, he took a job writing. Here he felt he could contribute something of value. In this first job he was writing complex and highly mathematical reports; Wolff soon switched to magazine work, which was of more interest to him. He returned to school and studied evenings for a master's degree in applied physics. "I went back to learn more physics, not for vocational goals."

Innovation is the third magazine for which Wolff has worked, and is the least technical. "It is about how you manage technology, not about technology itself." The magazine is published by Technology Communication, Inc, which provides a variety of information services (seminars and videotape packages, for example) for technical managers. Wolff often spends more of his time working on these other services than he does writing.

How is Wolff's physics background of use to him? "I'm not terribly interested anymore in writing about a new subatomic particle; I've become more and more concerned with how to steer this technological revolution. Of course, I never could have gotten to this point without a technical background. How can you run seminars for technological managers without knowing what their problems are?"

Investment analysis

Now an investment analyst with Dominick & Dominick, a New York brokerage firm, Phil Bradford has been interested in finance for many years. "One of the reasons I chose Columbia [where he received his doctorate after studying under the interdepartmental plasma-physics committee] is because, as well as having a fine academic reputation, it's in New York, the mecca of business." When he first finished school he went to Bell Telephone Laboratories, where he worked on satellite antennas and radio astronomy. In

PHOTO BY ROSEMARY GAFFNEY

"I never felt that my education should confine me to a particular employment area."

1968, when he graduated, says Bradford, there was not yet a severe shortage of jobs. He considered university research but finally rejected it because of the heavy tie-in with military support, which he feels unfavorably influences research directions, as well as because of the relatively low salaries.

Bell Labs, he says, was "the best of all companies I could have gone to work for." He was, however, dissatisfied. "I found that in basic research, one has to devote considerable attention, over a long time span, to a given project. And this is a strain. I wanted to be more flexible, to move from project to project if good results appeared unlikely."

During his graduate-school days, Bradford had some experience in finding financial backing for new businesses. Finance is something he's been interested in for many years. "I had always thought, in the back of my mind, that I would like to be doing financial research. The question was, would there be opportunities in the Bell system. And the answer was that I felt the more lucrative opportunities were elsewhere."

Bradford felt that there was a good chance to interest investment people in what was going on in science and technology. "I had a certain selling job to do." Dominick & Dominick's reputation in financial research was known, and there he found a suitable market for his talents.

Although Bradford's work is related to several Dominick & Dominick activities, his own job is the same in all; he evaluates a company's technology and products to determine whether or not it has a cost or performance advantage over existing technologies. "There are many financial opportunities whose evaluation depends on understanding how some business will be affected by a new physical process."

Dominick & Dominick, as well as its clients, are increasingly interested in technological arguments. They are hoping to avoid any mistakes due to a lack of awareness that a new technology could make other products obsolete. For example, higher-generation computers adversely affected companies that invested heavily in earlier models.

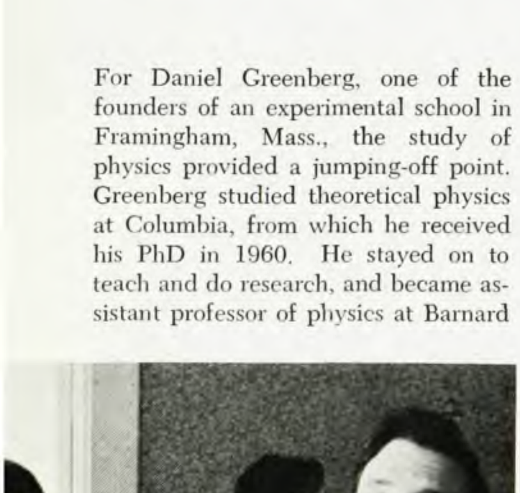
"I do as much work knocking down stocks that are clearly too high as I do in finding investments with a high potential value. I talk a great deal to other physicists." The ability to extract from another physicist what he's doing and why it might be commercially important, and to translate that information for his employers, is an important part of Bradford's job. "I attend both scientific meetings and stock-analysts' meetings."

Bradford appears to have convinced D & D of his value, and they are now establishing, largely at his urging, a series of technology seminars. He wants to make the portfolio managers and securities analysts aware of scientific and technological developments, rather than give any particular financial recommendation. He is inviting a number of respected scientists to speak at these seminars. "Many people in the investment community don't know the difference between a helium-neon laser with very little power and a great big CO_2 laser." So far as Bradford knows, this is the first modern attempt (since the "invention emporia" of the last century) to bring scientific ideas to people with money.

Bradford is still quite interested in plasma physics and often goes up to Columbia to visit the laboratories. But, he says, "I never felt that my education should confine me to a particular employment area; rather I have always believed in the separation of income-producing activities from intellectual activities." He does not feel that one should select an education on the basis of employment considerations. "I think that could be a very unfortunate anticipation."

Experimental school

For Daniel Greenberg, one of the founders of an experimental school in Framingham, Mass., the study of physics provided a jumping-off point. Greenberg studied theoretical physics at Columbia, from which he received his PhD in 1960. He stayed on to teach and do research, and became assistant professor of physics at Barnard College, the women's undergraduate division of Columbia.



". . . you see that everything man's ever created is due to his ability to use his mind in an unfettered way."

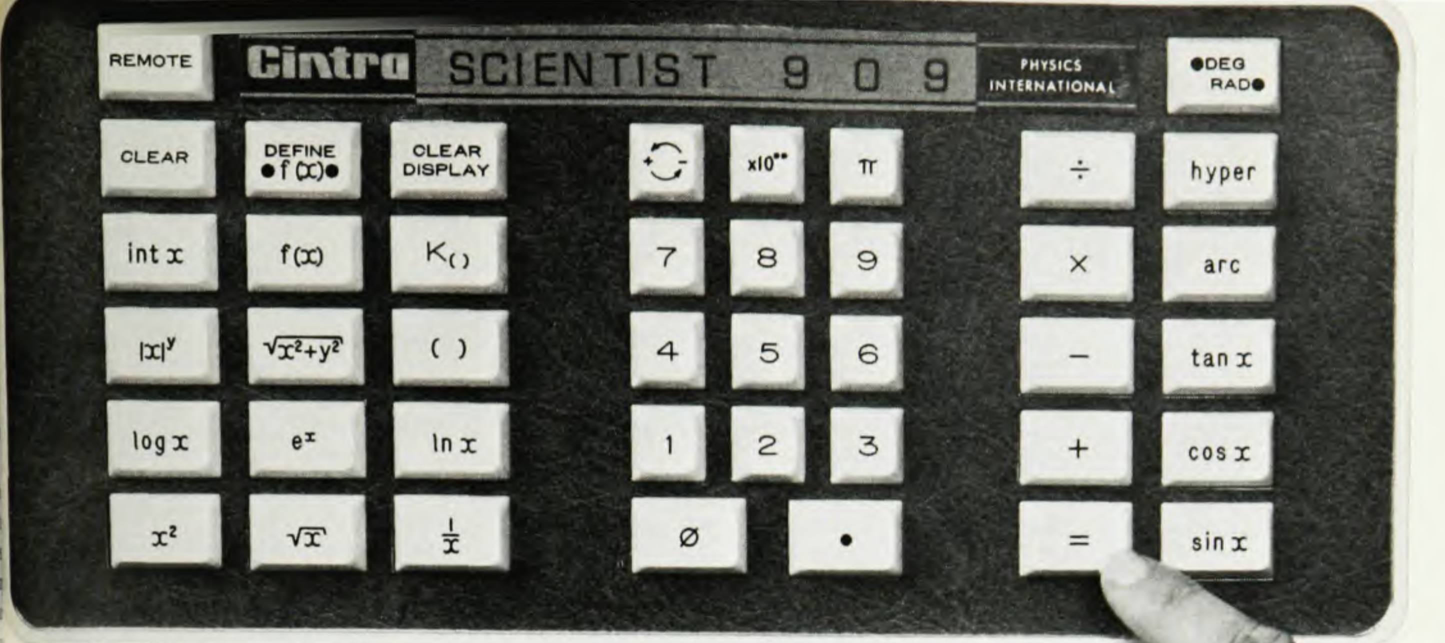
In the early 1960's he became interested in studying history of physics and did some writing in this field. His interest originally came about for physical reasons; he wanted to know the origin of the concepts he was working with. Greenberg continued to work in history of physics rather than in physics itself: "The sort of work I was capable of doing in physics was too routine. You realize, after a while, that you're not Niels Bohr or Albert Einstein, and you have to decide whether you want to be a very bright hack, or you want out . . ."

His decision, he says, was not even primarily a career question, "I felt that the things I was learning about the world from physics weren't being done anymore in physics." In his readings he found that any significant advance in the whole history of physics came "as the result of wild flight of imagination. The realization that physics, the most perfect of all the perfect sciences is, at its heart, based on the ability of man's imagination to soar, was such an unexpected result. It made me realize that the greatest asset you've got is a man's free mind."

This realization, Greenberg points out, is not one that other people have not had. "The physics in my case made it a contrapuntal background. Because you see that here, of all places, the imagination has played a key role. You already know it's important in art, music and literature. . . . You see that everything man's ever created is due to his ability to use his mind in an unfettered way. Then you see that the entire educational system is permeated by the linear view of things, by deciding what minds ought to contain and then trying to put it there. This is a tremendous violation of the creative element, of the imagination. And what you're getting out is an incredibly wasteful situation where most of your people are dead before they're 20."

Greenberg and his wife decided, about four years ago, to start the school because they had children, not because they wanted to get into education: "I was doing history of philosophy of science and editing and writing and having a great life." But when they started to look for schools for their children, he says, "We were ready to move anywhere in the world if we had found a school like this . . . but we had to do it all from scratch."

The school that the Greenbergs helped found, the Sudbury Valley School, is in its second year of operation and is accredited by the town. But it is a very unusual school whose



Talk to me, Cintra Scientist.

What should I ask you?

Ask a lot. Ask, for example, the solution to $(A + B \times C)^{(D+E\times F)} =$, where A, B, C, D, E and F can be data or any combination of keyboard functions such as sin X, log X, e^X, etc. Just key it in exactly as written and you'll have the answer by the time your finger is off the equals key. The Scientist's dynamic range is 200 decades with 10 significant figure accuracy.

Try it yourself. Take an everyday slide rule operation such as $286.4 \times 10^{20} \div .004612 \times 10^{12} =$. The answer is immediate! Your entered data can be in scientific notation, floating point or combinations of both. The Scientist will keep track of decimal points and exponents for you. All keys are hardwired, and note how logically they're arranged. Power? **Ultra-power** is more like it.

Stored constants? You get 26 with the basic model, up to 122 optional.

No machine language to learn! The Cintra Scientist talks your language. Press the keys and find out for yourself in just five minutes.

Behind the keyboard? Hermetically-sealed MOS/LSI and integrated circuitry assures reliable, trouble-free performance.

Can you operate as a computer, too? Certainly. With the Cintra Model 927 Programmer, up to 25,600 consecutive steps can be performed automatically in addition to loops, branches and more, the modular design allows expansion into a mini-computer with peripherals such as the Cintra 941 Printer, plotters, and A to D converters for on-line/off-line applications.

Just $3,780 puts the power of the Cintra Scientist at your fingertips. Now ask yourself a question. Shouldn't I find out more about the Cintra Scientist?

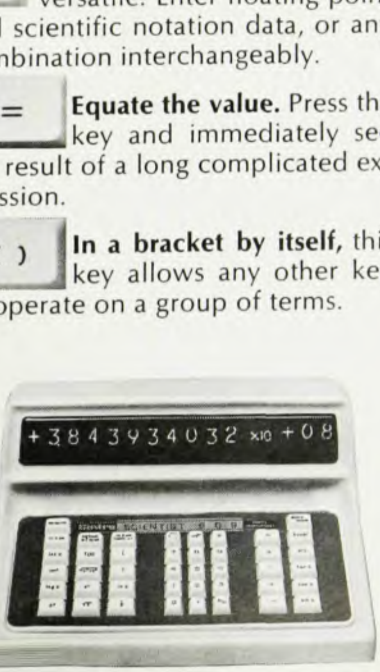
Look at these unique keys

$|x|^y$ **Ultra-powerful.** Includes all 10-digit integer and non-integer values of x and y.

x10 An **order of magnitude** more versatile. Enter floating point and scientific notation data, or any combination interchangeably.

= **Equate the value.** Press the key and immediately see the result of a long complicated expression.

( ) **In a bracket by itself,** this key allows any other key to operate on a group of terms.



DEFINE f(x) / f(x) Use this **highly functional** 84-keystroke programmer for series expansions, transcendental equations, operational analysis, etc. Define f(X) as any function up to 84 consecutive steps; thereafter execute this defined function with one f(X) keystroke (254 steps opt.).

$K_{()}$ **Constantly works for you.** Set constants equal to K_1, K_2, etc. To reuse any constant in any equation, simply key $K_{()}$ and the subscript thereafter. Stores up to 26 (122 optional) 12-digit constants including exponent and signs.

$\sqrt{x^2+y^2}$ **Statistically proven** most useful for least square sums, RMS, and vector magnitudes, etc.

DEG RAD View your data from a **better angle.** Keylight shows which trigonometric units you are using.

REMOTE This **far out** key lets you communicate with up to 99 instruments: printers, plotters, computers, A to D converters, etc.

Your **answer** *is the Cintra Scientist—the 24-pound computer at your fingertips.*

Cintra
Physics International

440 Logue Avenue
Mountain View, California 94040
(415) 969-9230
Cintra Incorporated—a subsidiary of Physics International Co.

aim is to provide an environment for children to grow up in. There is a good library, art supplies, music and other "equipment," but there is no educational program. If a child (the students range from 4 to 18 years old) wants to study something, he must do it on his own initiative. When asked how the children know what it is they want to learn, Greenberg says "Children today are overexposed, not underexposed. They watch television, for example. These kids know, from the earliest age, how to go about getting information that they don't have. Here they learn that they've got only their own resources to rely on."

Although the school has no educational program, it does have very specific rules that everyone, from the four-year-olds to the staff members (and including visitors) must obey. There are weekly school meetings at which any student or staff member who violates a rule is tried and, if found guilty, suitably punished. Every student and staff member has an equal vote at these meetings. Says Greenberg, "Four-year-olds have the same vote as I do. But they don't vote on issues that they don't understand." He points to a little boy who is intently drawing: "Ask him what the rules are. He'll tell you that you can't run in the halls and that you must put things away when you've finished with them."

What kind of people does he envision his students will be? "Even if they end up doing routine types of things, they will not be doing them in a routine way; they'll be doing each step through a conscious decision to do that step." Developing these kinds of people, he says, doesn't mean that the routine necessary things (building bridges, for example) aren't going to get done.

"I have a tremendous respect for doing work. The whole point of this school is to allow you to do to the end whatever serious work you're interested in. I've done some of my best writing here. The man who's going to be creative in physics is going to do it because he's consumed with a passion to do physics."

Operations research

Larry King received his AB and PhD in theoretical high-energy physics from Harvard College and the University of Illinois, and then went to work for the Lambda Corp, an operations-research company in Arlington, Va. "I don't notice any abrupt change from what I did in graduate school to what I do now," says King. "Mainly, what I was doing was model building, and that's very much what I'm doing now. They both rely very heavily on a particular class of mathematical techniques. The fact that it's not physics affects the names of the concepts, but, to a large extent, it doesn't affect the concepts themselves."

"I find operations research very similar to what I imagine physics was like perhaps a century ago."

Through operations research, at least as it is practiced at Lambda, one tries to maximize a function. This function may be national security or the profit of a certain company. Usually, when a problem comes to Lambda, it's because standard optimization techniques (often heuristic) have failed. To get an answer by routine methods, for example, may require years of computer time. Lambda's job is to find a reasonable way of solving the problem. "I find that OR is very similar to what I imagine physics was like perhaps a century ago, when it was not highly organized. You were pretty much on your own, and there were not many people who could answer your questions because no one knew more about what you were doing than you yourself did."

There's a great deal of freedom, says King, about the kinds of problems you get into. "I don't look for problems to which I can apply my experience; I look for problems that interest me. The kinds of problems that I like are problems that involve model building, where you have a situation that has not been thought about enough for anybody to have a realistic idea of what's going on."

At the time King started graduate school, he had the general intention of taking a postdoc when he had finished and doing pure physics. He says he is not certain whether or not he was swayed by economic conditions. "I considered some teaching offers, and they looked attractive from a certain standpoint, but they didn't really look as interesting as the work that was going on here."

Lambda has a physicist, Hugh Everett, as chairman of the board and another physicist, George Pugh, as a vice-president; their presence influenced King somewhat in his decision to join the company. "There are discussions here on topics of interest to people who have gone through this [physics] training."

King doesn't believe that OR, as a discipline, is more important or relevant than physics, as a discipline. "I think if we're going to solve world problems 50 years from now, we have to be doing things that may seem completely irrelevant now. But I was unable to find particular problems in physics that I considered to be relevant from my own standpoint now, and I did find them in OR. The individual problems that I can solve, that I can be closely involved with, I consider to be more important in OR than in physics."

The kinds of satisfactions one gets in OR vary. There are times, according to King, that the work appears more relevant because people (the customers) are clamoring for the result, whereas in physics it is generally you who are pushing your own ideas and trying to get them published. King also likes being closer to the "real" world. "I like to see the results that I calculate actually being used to make money, or whatever the criterion. You get a more immediate measure of success." But, continues King, (who enjoys deeply analyzing chess moves), "I think the greatest satisfaction is in the model, in constructing what is a reasonable model that mirrors an aspect of the real world." □