state & society

Creutz sees a gradual increase in NSF support of applied science

The new NSF assistant director for research, Edward C. Creutz, is a physicist with experience in university and industrial life. He is responsible for roughly half the NSF budget. When we visited him recently in his NSF office, Creutz told us that NSF is deeply committed to preserve its support of fundamental science. However, for new programs, NSF's organizing principle is what impact science has on society.

Creutz comes to NSF from Gulf General Atomic, where he was vice-president in charge of research and development. He is also chairman of the AIP Corporate Associates advisory committee. Before joining General Atomic in 1955 Creutz was head of the physics department and director of the nuclear-research center at Carnegie Institute of Technology. He has worked in nuclear physics, nuclear reactors, accelerator design, meson reactions, and thermonuclear fusion.

Do you see a larger role for NSF because of cutbacks in mission agencies?

Certainly NSF has a responsibility to make sure that good basic research, being dropped in many areas through the effect of the Mansfield amendment on DOD, not be allowed to die. The Foundation will certainly pick up some of this—not on an across-the-board basis because we just don't have the money to do it. Proposals will be reviewed and hopefully a sensible fraction of the good work will be continued under NSF support.

What fraction of proposals received can you support?

There's been quite an increase in proposal pressure in the last year or so. The fraction varies with the field and it varies with time. It's something like 25–35%—an average figure of about 30% of the proposals that come in are supportable, but usually at a reduced rate. If you ask for a dollar figure it would be less than that. It is not unusual to have to reduce the requested dollars by a factor of two on a given program. A few years ago the fraction of proposals supported was more like 85%.

continued on page 62

Edward Creutz says NSF is deeply committed to preserve its support of fundamental research. For new programs, though, emphasis is on impact on society.

IRRPOS looks for relevance to society's problems

IRRPOS is one of the least euphonious acronyms on the Washington science scene, but it is probably one of the most significant. It refers to NSF's \$13-million program on Interdisciplinary Research Relevant to Problems of Our Society. In the view of physicist Joel A. Snow, who heads the program, IRRPOS holds some interesting challenges for physicists, at least for those physicists who are willing to apply their talents to unconventional problems in unconventionial ways.

IRRPOS is a major part of NSF's effort to bring scientific resources to bear on major national problems. Thus, it fits in with the current emphasis on "relevance" in Federally supported research. A sampling of projects already underway with IRRPOS funding illustrates the range and interdisciplinary character of the work: different aspects of environmental pollution by lead; impact of regional development on a semiprimitive environment; growing demand for energy; pilot research in technology assessment; guidelines for a national program of environmental research laboratories; political and scientific effectiveness in nuclear-materials control; design and management of environmental systems; fire-problems research and synthesis; environmental quality and social needs; urban science and engineering; land use and energy-flow component of a model of society.

The origin of IRRPOS within NSF goes back over a year. In October 1969 the Office of Interdisciplinary Research, which Snow heads, was established. (In addition to overseeing IRRPOS, Snow's office serves a "switchyard" function—channeling to other parts of NSF or to other agencies ideas and proposals that seem promising but which IRRPOS cannot fund.) IRRPOS was formally announced last December. In fiscal 1970, NSF allocated \$6 million to IRRPOS; for this fiscal year, which began on 1 July, \$13 million is planned. Very roughly a third of IRRPOS' money will go into the broad area of technology assessment, but the total program budget has not

SNOW

been divided into precisely defined research categories.

At the end of fiscal 1970 NSF had received over 1000 inquiries about IRRPOS, about 200 preliminary proposals, and about 50 formal proposals. The Science Foundation has made 21 grants. Some \$2.7 million went to state universities, \$1.1 million to private universities, and \$2.1 million to various nonacademic organizations.

Snow, 33, has a PhD in solid-state theory from Washington University. He joined NSF as a program director in theoretical physics and moved to the Office of Interdisciplinary Research last November.

Snow discussed with PHYSICS TODAY the problems and opportunities for physicists in interdisciplinary research on socially relevant problems. He lists, as good illustrations of the ability of physicists to move into new areas, the World War II development of the nuclear sciences and electronics, and the development in the 1960's of the space sciences. These past success stories, he notes, shared some characteristics with the present thrust of IRRPOS: They were interdisciplinary; they were strongly problem-oriented; they required analyzing total systems; they were responsive to broadly accepted national needs.

Previous accomplishments notwithstanding, physicists may have trouble moving quickly and smoothly into IRRPOS-type work. One reason is that they will be obliged to go farther afield intellectually. Snow believes that physics is at least as good a preparation for interdisciplinary applied research as is training in any other scientific discipline. And he notes that many physicists have been able to move "horizontally" into other natural sciences such as biology, and also to do well in applied physics, engineering, and operations research. But Snow points out that it is not clear that physicists have any particular advantages when interdisciplinary studies lead them into, for instance, economics or sociology.

Then too, in Snow's view, physicists working on IRRPOS-type problems may suffer from a kind of "intellectual impedance mismatch." Physicists have "a tendency to seek the 'right' answers to problems. But in some of our problems of society we have to settle for some kind of a partial or interim answer, and then try to improve that answer as we go along. Unfortunately, the large problems of society aren't very neat; if they had been neat we might have solved them long ago. Many physicists I talk with get very impatient with the imprecise character of the real world.

"Another, related, problem is that people who are accustomed to dealing with the imprecise world in their own ways can get very impatient with physicists." Snow observes that physicists often tend to take a direct, intellectual approach to practical problems. "Then a physicist points to what he thinks is a reasonably exact solution to a problem, and tells people to go and fix it that way. But most public officials, say, live in a world where one doesn't operate that way, and they can be very put off by the air of self-assurance that the physicist sometimes brings to this type of work."

It is generally accepted that "think-tank" organizations have taken the lead in the last 20 years in interdisciplinary, problem-oriented research. Snow hopes that universities will be able to modify their traditional departmental structures to allow for more such work. He regrets that "it is still hard for physicists who work and publish on problems outside of physics to get reasonable professional credit for their contributions."

Snow points out that physicists have demonstrated on many occasions that they can carry on their regular work and stay current in their research fields, so long as their nonphysics work is brief or part-time. But those who embark, full time, on work outside physics run the high risk of dropping out of the mainstream of physics research. Snow admits that his own involvement and enthusiasm for IRRPOS are not without some regrets. "In another year I will have forgotten all about Green's functions."

—JBP

Creutz

continued from page 61

In what fields do you see NSF playing a larger role now?

One enlarged trend, of course, is to put much more of a component of relevance into the research, not only in physics, but in all areas of science. This is important; the world needs it; many scientists want to do it. There also is a danger that if one leans too far in this direction just to look at relevance, one is by definition looking at a shorter-term picture. One must keep a balance and not decide that science is only worth doing because we see now how it might be used. I'm not worried that the Foundation is going to jump too far in this direction.

For what fields of physics do you see more NSF support?

Well, certainly the areas of materials. In the things I used to be doing at Gulf General Atomic we were always limited in efficiency, simplicity and cost of nuclear reactors by the available properties of materials, usually high-temperature materials in that case, but also hardness, corrosion resistance and weldability. These are again practical questions, but they are obviously very closely related to our understanding of the solid state of matter. So solid-state physics I'm sure will continue to be an important area for support in basic science.

Plasma physics is primarily now the province of the AEC because of the possibility of controlled thermonuclear reactions, but there will be NSF plasma-physics support, and probably more at the theoretical end than at the device end.

Certainly the atmospheric sciences, the physics of the atmosphere, the environment of the earth in space, is a rapidly developing area. Not only the effect of the plasma environment, but getting down closer in the atmosphere itself—weather effects and things of that sort are getting increasing emphasis. Coming down perhaps even still closer to ourselves—the physics of the ocean, oceanography, is certainly going to develop rapidly.

Is NSF likely to support much basic research on pollution-related things?

Certainly all the things I just mentioned are along that line. Atmospheric science tells us how pollutants travel from one part of the atmosphere to another. The oceanographic question of distribution of pollutants in the ocean and the fluxes are certainly going to receive a lot of attention.

These studies tend to become multidisciplinary. One has to see where the

Changes at NSF

On 1 October Raymond L. Bisplinghoff became the first deputy director of NSF. Bisplinghoff, an aeronautical engineer, has been dean of MIT's school of engineering since 1968.

Other recent face and title changes at NSF occurred in the physics section, which is part of Edward Creutz's responsibility. Wayne Gruner, formerly head of the section, is now senior staff associate (planning) to Creutz.

The new head of the section is Paul F. Donovan, formerly program director for intermediate-energy physics. Marcel Bardon (on leave from Columbia as deputy director of the Nevis Laboratory) is the new program director for intermediate and high-energy physics.

Replacing Langdon T. Crane (now director of the institute for applied mathematics and fluid dynamics at the University of Maryland) as program director for atomic, molecular and plasma physics is Rolf M. Sinclair, who comes from the Princeton plasma-physics laboratory.

Harold S. Zapolsky and Angelo Bardasis are now associate program directors for theoretical physics; both are on leave from the University of Maryland. Joel A. Snow and Bernard Chern, both formerly with the theory program, are now respectively head of IRRPOS (see story on page 61) and a program manager in the NSF division of institutional development.

Continuing in their former positions are Howard W. Etzel (solid-state and low-temperature physics), J. Howard McMillen (elementary-particle physics), and William S. Rodney (nuclear physics).

lead comes from, where it goes, and how it goes there, the flux of the lead as well as the effect the lead has on organisms. So there's a lot of physics there; there is also a lot of chemistry and biology. And it's not separate from the social sciences because there are questions on the economics of lead and the social patterns of using leaded gasoline primarily, and also leaded paints.

In what areas do you think you will be reducing your physics support?

We've never been a very large supporter of high-energy physics (AEC is the larger supporter there). With the Batavia accelerator coming along—a very, very large investment—the NSF component of high-energy physics looks a little bit puny. We think we are now supporting some very important projects. But it's going to be hard to maintain an appreciable share of the high-energy physics support because of the large AEC investment.

Have you been able to do anything for some of the facilities that are particularly hard hit?

Yes, we're trying to. We're looking at these facilities being slowed down or closed out. We certainly can't, on a one-for-one basis, pick up all that are dropped by DOD or other agencies. We will study each facility on an individual basis; it has to be competitive with other areas of science or other scientific work in the same area.

Will your background in industry help NSF to do more things with industry than it has before?

I hope that's right, because, of course, NSF has done very little with industry traditionally and even legally until the Daddario Act of 1968, which enables the Foundation to do work in applied science as well as basic science.

Do you think there is likely to be a significant increase in the fraction of NSF money going to industry?

There will be a gradual increase because that fraction is essentially zero now. There are some areas where I think it's not only appropriate but really necessary to generate and encourage the ties between academic institutions and industry.

One of my strong interests is controlled thermonuclear energy. Gulf General Atomic has a substantial program; in fact I guess the largest industrial program in that area. The toroidal multipole, which was built by Tihiro Ohkawa, has now held plasma for the longest time yet—half a second, which is really long enough for a controlled thermonuclear reaction—but the temperature is too low and the density is too low.

The controlled-thermonuclear program has, of course, been largely carried out by the AEC laboratories and by some universities, and very little industrial effort existed because it's long range. Industry generally has to figure out how it's going to get its money back for research, which is quite proper.

But here's a case where important advances have been made by industry and, of course, the program has been well coordinated with Government laboratories and universities. This particular job was done by industry and not by universities. I don't think that this is a particularly unique situation.

What do you think about the oversupply of doctorates in physics?

We're very concerned, not just about this question, but about what the proper spectrum of educational programs should be. There's a lot of talk about some sort of an education that does not lead to a career as an independent basic researcher. Although it would be for an equivalent length of time as the PhD, the bent would be more along the lines of *applying* the education broadly.

Some of it may come out of the IRRPOS program, some will come out of the environmental problems.

Why shouldn't a PhD in physics, for example, work in a city government, or a state government, or Federal government? Of course there's nothing about education in science or in physics particularly that means there aren't applications of this discipline, this way of thinking about knowledge, putting knowledge together, synthesizing things, that says that it can't be useful in other activities besides research in science.

Do you think that physicists intellectually or otherwise have a headstart among scientists in getting into other areas?

I don't know if it's a headstart. I think there are some things specific about physics training: the training to absorb large amounts of information, to be very critical of information—consider the source, the evidence, the degree to which information holds up under careful examination, innovation, techniques of measurement. Physicists have always been very productive in developing new instruments to look finer and finer at the structure of nature—to try to see in greater detail what the phenomena are. This has, of course, been very useful to other fields of science and in the development of special instrumentation, starting with spectroscopy, up to nuclear magnetic resonance and electron spin resonance, Mossbauer effect, photoelectricity.

What are the prospects of a turnaround in the physics-funding situation?

We're just beginning to work on our fiscal 1972 budget. We certainly hope for some improvement then, but it's much too soon to say what the situation will be. This is a very bad year. Probably for the next couple of years we are going to have serious problems of supporting all the work that really should be supported. But we certainly intend for the Foundation to do everything we can to bring this picture back to where good science is supported, until much more of the good science is supported than it is now. —JBP and GBL