THE ECONOMIC ASPECTS OF CYCLOTRON APPLICATIONS: A CASE STUDY AT CROCKER NUCLEAR LABORATORY

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Abstract

The opportunities and problems associated with deriving a major fraction of facility support via recharges on cyclotron applications are illustrated through analysis of operations at the Crocker Nuclear Laboratory during the past seven years.

Introduction

Seven years ago, facility funding of the Crocker Nuclear Laboratory, with its 190 cm sector focussed cyclotron, was abruptly terminated by the A.E.C. The budget during the last year under the A.E.C. was about $760,000 for nuclear research and facility support, including both theoretical and experimental programs. Beginning in October, 1971, the laboratory has been largely supported through recharges made for use of accelerator beams, shop time, and a large number of specialized services based upon accelerator beams. The level of support generated in this period is shown in Table 1.

Table 1
Support for activities of Crocker Nuclear Lab

Year	Total Support	N.R.S.F.*
1971 (CY)	760 K$	-
1973 (FY)	708 K$	235 K$
1974 (FY)	748 K$	321 K$
1975 (FY)	622 K$	304 K$
1976 (FY)	952 K$	492 K$
1977 (FY)	1,065 K$	562 K$
1978 (FY)	1,300 K$	861 K$

* Nuclear Research Service Facility

While the total support figures can be directly compared to the old facility grant, a new catagory enters in 1973, the Nuclear Research Service Facility. Funds in this catagory are independent of grants, although they may be drawn from grants in the form of recharges for laboratory services including beam time. In the beginning, they represented only cost recovery for services, but they have included in recent years income from a variety of cyclotron applications and some activities that have been a natural outgrowth of the presence of a body of highly trained people such as instrumentation and computer experts. CNL groups, such as the Digital Systems Division, service high technology systems on the Davis campus such as electron microscopes and computer terminals, resulting in major savings to the university and maintenance of valuable personnel at a high level of both staffing and expertise. They are now responsible for a major share of all microprocessor design and development,including programming, for the campus. While this work is not technically a cyclotron application, it most certainly aids cyclotron applications and illustrates the importance of people in such programs.

Administration

With the efforts being made to increase cyclotron applications by nuclear physicists and chemists, administrative changes occurred. In almost all cases, the successful application programs involved a degree of retraining of people into new areas, and it was natural that associate directors be appointed in order to coordinate efforts and initiate developmental programs. At this time, there are associate directors in the areas of Physics, Chemistry, Medicine, and Environmental Programs. They are involved both in grants in their areas and in service programs in the laboratory. As programs gain in stature and funding level, they will also need administrative support, with material sciences and biology being the next likely areas for associate directors. One of the major duties of the associate directors is to oversee personnel in their areas, as one of the problem areas in cyclotron applications is in training and promoting specialized postdoctoral staff in the face of a limited supply of potential scientists and constant raids by industry and national laboratories. In addition, bookkeeping and financial administration has become far more complicated in the face of a very large number of income sources.

Summary of Activities

A summary of the activities carried out at CNL in the past seven years is shown in Figure 1. There has been an approximate division of basic and applied activities that has not materially changed in the recent past. Approximately 40% of all activities have been basic, about 40% applied, and about 20% service in nature. It is most important to state at this time that virtually all CNL activities involve research, and that what may appear to be applied research or even service activities to a nuclear scientist may be frontier basic research in biology, atmospheric chemistry, history, or geology. It should also be noted that basic physics and chemistry have gained a large share of university support. Some of this is historical in nature, as it was necessary to aid students to finish theses started under A.E.C. funding. Figure 1 also shows those areas that are increasing rapidly and show promise of further increases.

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0018-9499/79/0400-2432$00.75

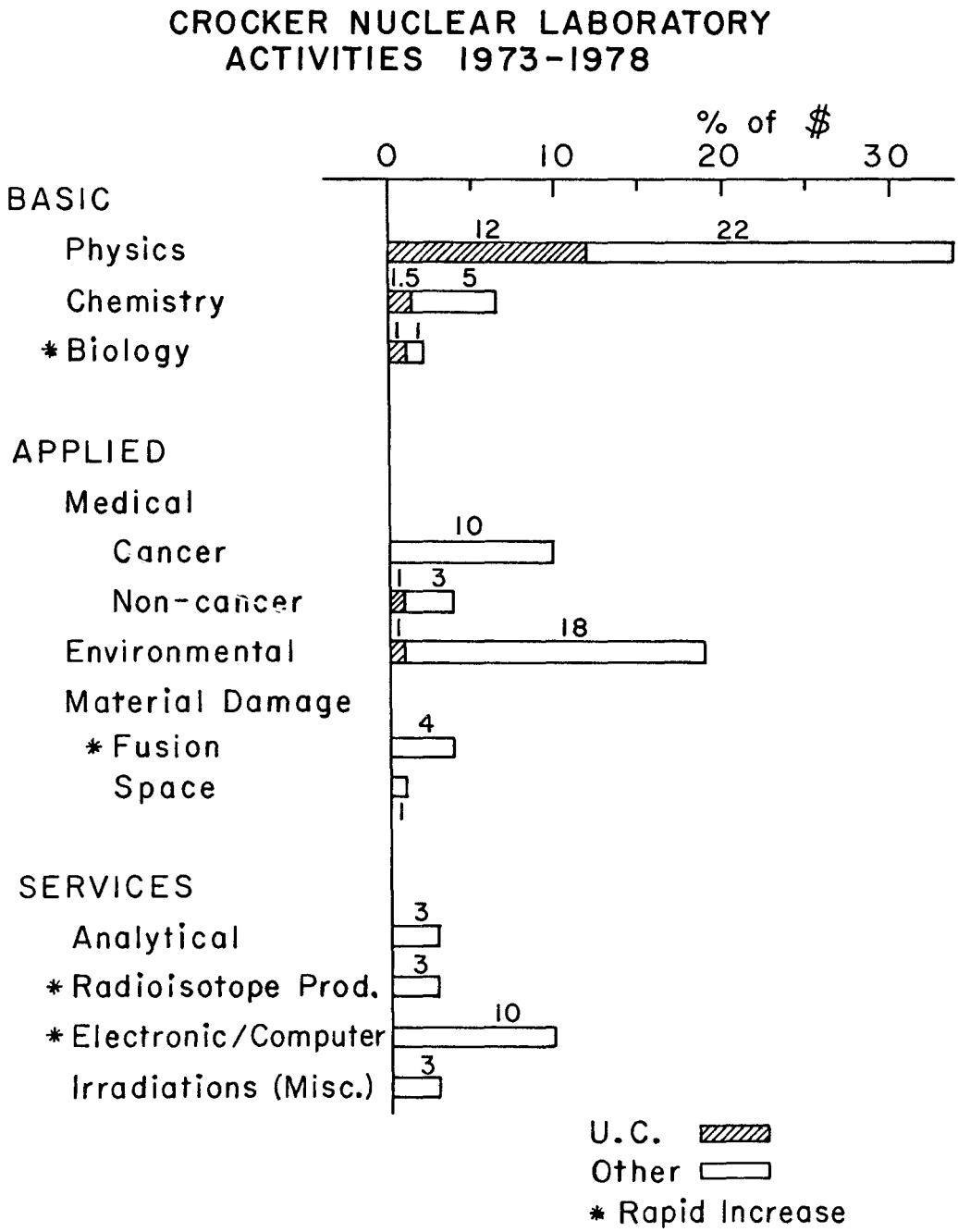

Figure 1

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It can also be asked as to the ultimate source of these funds. This is shown in Table 2.

Table 2

Sources of CNL Income

Source	Total	Division	Fraction
N.S.F.	28%	Physics	22%
		RANN/ASRA	6%
D.O.E.	11%	Chemistry	5%
		CTR/MFD	4%
		Environment	2%
N.I.H.	13%	N.C.I.	10%
		Other	3%
E.P.A.	1%		
Calif.	9%	Air Resources Board	9%
Industry	10%		
U. of Calif.	28%	Services Rcd.	10%
		Grants, etc.	14%
		Administation	4%

Problems

In the course of developing cyclotron applications, an effective recharge system had to be instituted, one that would stand up to state and federal auditing procedures. This has resulted in equivalent beam charges to all users, although there is a legitimate difference between university users and other users. However, the concept of free beam time has had to disappear, for federal requirements are that the government be charged the minimum rate used by the facility. Thus, the cyclotron must stand idle if no funded user is able to pay for its use. In 1975, the cyclotron was idle 2,600 hours, fully staffed, fully operational, and with many scientists anxious to do research on it. This problem can be mitigated by grants for research to CNL from the university, making CNL a funding agency that can fund beam and shop services and small additional funds. The amount thus funded each year has risen to about $75,000.

A second problem involves the question of who will fund the new programs. It is difficult to find developmental funds, and any attempt to hold back operating funds will not stand up to audit. CNL benefitted from NSF - RANN funding in the first three years, but few agencies are interested in such efforts. Again, the answer has been a combination of university developmental grants, extramural grants in small amounts, and a certain deliberate overstaffing that allows some flexibility in duties in areas under active development.

A rather serious problem involves the question of academic staffing. Work in applied physics does not neatly fall into university departmental structures in many cases. Thus, few young faculty dare to put much time into cyclotron applications prior to becoming well established in their own fields - preferably with tenure. CNL has responded by staffing postdoctoral positions of extended duration, unlike standard 2 year postdoctoral appointments. These have unlimited duration but are on "soft" funds that exist only as long as the programs are financially viable. Fortunately, some of these positions have turned into faculty positions, at Davis and elsewhere, so that so far they have worked out well. The scientists must become experts in the field of application, publishing heavily in that field, attending meetings, and interfacing with funding agencies.

A final point that must be made is that the success of such applications is in some ways self-limiting. If enough income is generated so that it might appear profitable to industry, some company might initiate programs in this area. In this case, it is very easy for the company to threaten suit against the university in order to eliminate the university's tax exempt status with the I.R.S. Thus, the university must immediately cease such activities upon recommendation of university legal staff, with loss of both income and unrecovered costs of development. This is a major problem in the sale of radioisotopes.

Conclusions

The case study of Crocker Nuclear Laboratory has shown that cyclotron applications can indeed play a major role in facility funding, if care is taken to apply the facility to areas that are well suited to accelerators, poorly handled by other techniques, and not in direct competition with private industry. It has also happened that, scientifically, the laboratory has never been healthier than at present, with almost 8 times as many faculty associated with its programs than under A.E.C. funding and a far greater production of scientific works and publications. While few facilities may have as large a mix of applied work as CNL, the scientific and economic benefits to be gained from applied programs make a significant component of such work desirable in almost all facilities.

Abbreviations

A.E.C.	U.S. Atomic Energy Comission
N.R.S.F.	Nuclear Research Service Facility of the Crocker Nuclear Laboratory
C.N.L.	Crocker Nuclear Laboratory
U.C.	University of California
N.S.F.	U.S.National Science Foundation
R.A.N.N.	Research Applied to National Needs section of the N.S.F.
D.O.E.	U.S.Department of Energy
C.T.R.	Controlled thermonuclear reactor, now called M.F.D.
M.F.D.	Magnetic fusion device
N.I.H.	U.S.National Institutes of Health
N.C.I.	U.S. National Cancer Institute
E.P.A.	U.S. Environmental Protection Agency

0018-9499/79/0400-2434$00.75

** DISCUSSION **

M. CHAUDHRI: Does your applied work get full recognition from your colleagues in pure and basic physics?

T. CAHILL: Philosophical differences exist over how applied programs are viewed in some physics departments. These can make it difficult for a young faculty member to gain recognition for his efforts in an applications program. Because nuclear experimentalist faculty are in short supply, we have hired into the group postdoctoral academic staff people who can spend the time to become knowledgeable in one field of work — this involves publishing papers, going to meetings, joining associations, and so forth. We have found that one of these people can interface with maybe five or six people coming in from outside, and come up jointly with viable and truly interdisciplinary research work. They appear then as co-authors on publications and the like. We would not have nearly enough faculty members to carry on our program.

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