million Marine Science Services building at the Gloucester Point campus. The Eastern Shore Laboratory at Wachapreague, on Virginia's Eastern Shore peninsula, offers additional access to embayments, salt marshes, barrier islands, and coastal waters. The Wachapreague facility has laboratories for mariculture and research as well as classroom space and a dormitory.

The library currently contains some 31,000 books and bound journals and offers extensive interlibrary loan and literature search services through the Virginia State Library Network, the On-Line Computer Library Center (OCLC), and DIALOG. It is a depository for nautical charts and topographic maps of the area. The library occupies approximately 8,400 square feet of floor space in the new Marine Sciences Services Building.

The School's computer center is comprised of a PRIME 850 computer with peripherals that are housed in the computer center. Access to the PRIME is through serial RS-232 ports, both dial-up and hard-connected. There are many remote terminals and microcomputer devices throughout the SMS.

The fleet of research vesels operated by the School's Vessel Operations group include about 30 boats which range in size from small, aluminum jon boats and inflatables to an 80-foot steel-hulled vessel.

The Institute frequently works closely with other research organizations in the Chesapeake Bay region such as the National Aeronautics and Space Administration. There are numerous arrangements, both formal and informal, for sharing and joint use of equipment and facilities. The Institute is a charter member of the Chesapeake Research Consortium, Inc. VIMS also is a member of the NOAA sponsored Southeastern Consortium for Undersea Research (SECURE) and participates in the Virginia Sea Grant Program as a member of the Virginia Graduate Marine Science Consortium. VIMS scientists also have access to the SECURE program's Southeastern Undersea Research Facility (SURF) operated by the University of North Carolina. SURF operates an advanced diver support vessel, the SEAHAWK.

G.   FINANCIAL RESOURCES

1.   Arts and Sciences

The doctoral programs of the School of Arts and Sciences are reasonably well funded, but the MA programs are not, especially the newer ones in American Studies and Anthropology. Funding for all graduate programs has not kept pace with inflation or with our academic competitors.

Consequently, we have been unable to attract the best graduate students even in the state. In the face of Williamsburg's high costs, particularly in off-campus housing, graduate assistantships of less than $4,000 (plus tuition) are simply inadequate, especially for married students. The low level of our graduate stipends is a universal matter for comment by the external consultants who help in the periodic evaluations of our graduate programs. Annual increases should be built into the budget of each graduate program rather than waiting several years to play catch-up, during which time we may lose many of our best candidates.

In addition, the inadequate salaries of the faculty have impeded the improvement of graduate education at the College by depressing morale,

causing faculty members to seek outside or alternative employment, and curtailing the travel and research required by good scholarship.

2.   Law

In recent years the Law School, as well as other faculties and schools within the College, has suffered from inadequate salaries and fringe benefits. However, by reason of actions taken by the 1984 session of the Virginia General Assembly, it is expected that Law faculty salaries will soon be at the median range of accredited American law schools. However, funding for student aid and faculty travel are inadequate and the Law School Long Range Plan has identified funding for these two items as being "woefully short of meeting needs."

3.   Education

Three distinct financial aid programs exist to serve graduate students in the School of Education: graduate assistantships, graduate scholarships, and fellowships. During 1983-84, $60,000 was available for salaries for graduate assistants who perform work for the School. A total of $61,140 was provided for graduate scholarships and fellowships in the same year; 30% of the scholarship funds were used to cover tuition expenses for the graduate assistants.

The funds allocated to the School of Education are far below the amount needed to attract and retain consistently the highest quality students. Given the severe limits of graduate student aid for the School of Education, most master's and doctoral programs do little or no nation-wide recruitment. School of Education graduate students come primarily from within commuting distance of the College of William and Mary; furthermore, the School of Education's inability to offer substantial financial aid means that relatively few graduate students are able to enroll for full-time study.

One sign of partial relief is the College's recent decision to charge in-state tuition to out-of-state graduate assistants who earn at least $1,800 per year. However, this does not enable the School of Education to meet the financial aid needs of a great number of graduate students. The School of Education has failed to enroll some high quality graduate students to whom admission was offered (i.e., they chose to enroll elsewhere because of the lack of financial aid).

Another problem in attracting high quality graduate students to the School of Education is the relatively late date for notifying applicants about financial aid awards. Many well qualified graduate student applicants have opted to enroll at other institutions which have been able to make financial aid offers by early April.

Allocation of funds for Swem Library materials has been less than adequate. Additional funding is needed to improve the collection of professional education texts and related materials. On the other hand, funding for the Learning Resources Center in the School of Education has been adequate to meet the basic needs of graduate education programs. Additional monies would enable the Center to update and improve resources in a variety of areas, including Special Education and Social Studies. Some faculty members strongly recommend increased resources for purchase of videotapes and rental of films for use in their programs.

4.   Business Administration

Financial aid to graduate students is limited. Currently the allocation of financial resources to support graduate students is sharply skewed in favor of the Arts and Sciences program. A study completed by the Student Financial Aid Committee in April 1982 and based on 1981-82 data concluded that, on both per student and per faculty bases, Law, Business, and to a lesser extent Education received substantially less support for graduate assistants.

5.   Marine Sciences

The Marine Science Task Force (1984) has recognized a critical situation for student aid at the SMS:

> In the last decade, tuition at the SMS has increased by 140% while student stipends have increased only 27%. SMS student stipends must be increased by 46% in order to equal the average stipend offered in other programs. In a comparison of ten institutions with similar programs, the SMS ranked *last* in terms of financial aid available to students. The SMS has one of the highest out-of-state tuitions. Seven out of ten schools surveyed offered tuition waivers. Over the last decade, applications to the SMS have dropped from a high of approximately 230 to a low of 70. Over the same period the percent of applicants accepted to the SMS has risen from 10% to 80%. Of the students offered admission to the SMS, the percentage of those accepted and entering the SMS has declined from approximately 70% to approximately 35%.

More financial aid is needed to support assistantships in the School of Marine Science because of the independent funding arrangements there. The State Council on Higher Education has neglected to recommend support for the Marine Science Program. Consequently, student aid has come directly form the VIMS operating budget where its priority by necessity lies below the Institute's research responsibilities.

H.   PROJECTIONS

The future of graduate studies at William and Mary is not secure. Inadequate funding over the past ten years has led to a failure to keep up with inflation during a period of expansion for most graduate programs. This, coupled with the Federal Government's myopic inadequacies in understanding the importance of supporting graduate and professional studies during recent years (as eloquently stated by John Brademus in *Science*, March 2, 1984), has led to a critical situation for some of our graduate programs.

1.   Most of our graduate programs are hampered by very low assistantship stipends coupled with very high out-of-state tuition rates. This situation has led to a drop in the quality of students matriculating in some programs, particularly in those fields that are very competitive. Even with the newly adopted policy to offer in-state tuition to non-residents who receive at least $1,800 per year in assistantship aid, those students who need relief most are ignored (i.e., those who

are waiting for an assistantship position to become available in their first year, while they fulfill residency requirements and take a full course load). More financial aid is needed to support assistantships.

2.   Faculty salaries at the College have lagged far behind other comparable institutions during the last ten years. Recent salary increases approved by the State Legislature will improve this situation for some graduate programs; however, salary scales remain uncompetitive, even with other state universities in Virginia. Salary levels must be increased further if the College is to continue to attract and hold the high quality scholars who form the nucleus of our graduate programs.

3.   Faculty members in those programs that include high undergraduate teaching loads should be given compensatory time for the effort they expend in direction of graduate students. This was an accepted policy according to the 1974 Self-Study, but the practice has been discontinued over the last ten years. The College cannot expect to maintain high quality graduate programs without compensating the faculty members who are expending time and effort on those programs.

4.   The serial holdings in the College library collection must be expended particularly in newer fields where severe inadequacies have been identified (see above). Graduate scholarship cannot proceed without access to the appropriate literature.

5.   More funding should be made available for faculty travel. Such travel is imperative if our faculty members are to avoid intellectual stagnation and if they are to continually remain cognizant of the most recent developments in their fields of study.

Considering the severe financial constraints placed on the graduate programs at the College in recent years, the continued or improved quality of most graduate programs is a testament to the dedication and perseverance of the graduate faculties. It would be naive of the College to believe that it can depend on this dedication and perseverance indefinitely without soon addressing the acute problems identified above.

APPENDIX 1

Graduate Programs

Arts and Sciences

MA (Master of Arts)
American Studies
Anthropology
Applied Research
Biology
Chemistry
English
Government
History
Mathematics
Physics
Psychology
Sociology

MS (Master of Science)
Applied Science
Mathematics
Physics
Computer Science

PhD (Doctor of Philosophy)
History
Physics

PsychD (Doctor of Psychology)
Offered through the Virginia Consortium for Professional Psychology in Clinical Psychology

Law

JD (Juris Doctor)
— a three year program

MLT (Master of Law and Taxation)
— a one-year post-JD program

Education

EdD (Doctor of Education)
Counseling, including Counseling/School Psychology; Educational Administration, including an emphasis in Special Education; Higher Education

MEd (Master of Education)
Educational Administration, Guidance and Counseling, School Psychology, Special Education, Higher Education

MAEd (Master of Arts in Education)
Elementary Education, including an emphasis in Reading; Secondary Education, including emphases in Museum Education and Marine Science

Business Administration

MBA (Master of Business Administration)
— a two-year program

Marine Science

MA (Master of Arts)

PhD (Doctor of Philosophy)

XI.
RESEARCH

INTRODUCTION

In an increasingly complex society public universities must take the lead in extending the frontiers of understanding as well as in communicating existing knowledge. These traditional goals of higher education apply to the College of William and Mary no less than to other institutions that claim a national reputation for excellence. Even in a predominantly undergraduate university, teaching must go hand in hand with scholarly, scientific, and artistic contributions. A professor who would challenge students to achieve to the limits of their potential must test his or her own ideas in the intellectual marketplace. An instructor who would educate undergraduates for the choices of the future should be an active contributor to the knowledge on which those future decisions will be based. A teacher working with the intensity needed for excellence in the classroom requires the self-renewal derived from the excitement of new discoveries. For the most effective teaching of its undergraduate students, as well as for the intellectual apprenticeship of its graduate and professional students, the College of William and Mary must provide the facilities and incentives necessary to support individual scholarship. The purpose of the present chapter is to describe the extent to which the College presently accomplishes this objective.

The chapter is divided into three major sections: a retrospective view of the changes that have occurred since the last Self-Study, a cross-sectional comparison of William and Mary to other doctoral-granting institutions, and a set of projections and recommendations for the future. Data for the retrospective analysis have been obtained from the Development Office, the Office of Grants and Research Contracts, the Office of Institutional Research, and the Virginia Institute of Marine Science. Data for the cross-sectional comparisons were obtained from many of the same sources and are compared to national studies conducted by the American Association of State Colleges and Universities, the American Council on Education, and the National Science Foundation. In some instances the cross-sectional comparisons also involve data collected by the State Council of Higher Education for Virginia. Finally, the recommendations arise naturally from the data and from the Committee's deliberations, its discussions with administrative officers, and its informal contacts with student and faculty colleagues.

A. LOCAL RETROSPECTIVE

Any consideration of the progress that has been made in institutional support for individual research must begin with the specific recommendations

made in the 1974 Self-Study. Quite a number of these recommendations have been implemented, and their implementation has been a positive influence on the research climate at the College.

1. Review of Prior Recommendations

Research Leaves.

The 1974 Self-Study reviewed the history of funding for research leaves, and noted with approval that for 1972-73 three semester research assignments (a total of $22,000) had been added to the $38,000 available for 26 summer research grants. Nevertheless, the report's major recommendation was for a "program of research leaves financed at a level which will permit all members of the faculty to take regular leaves" (p. 415). Such a leave program, financed almost exclusively out of the indirect cost recoveries from sponsored research funded by external agencies, has been established and should be expanded. Complete records on the Semester Research Assignments and Summer Research Grants are only available for 1977-78 and after, and the applications and awards made in these two programs are shown in Table 1 along with the 1972-73 base. Applications for both programs are received and reviewed by the Committee on Faculty Research, and records of the Committee are maintained by the Office of Grants and Research Contracts.

Three aspects of the data in Table 1 deserve comment. First, compared with the 1972-73 base, there has been a substantial increase in the funds devoted to Summer Research Grants and in the number and individual amounts of Semester Research Assignments. In 1972-73 the summer research stipend was $1,000 ($2,400 in 83$), now the amount is 1/9 of the all-faculty salary average, or in excess of $3,000. It should be noted, however, that this stipend amount should be increased even further. In 1972-73 the three semester research leaves were roughly $7,300 ($17,600 in 83$) apiece. Now the Semester Research Assignments funds are used to replace the large majority of the 21 faculty members granted a leave (whether or not an individual faculty member will be replaced is a decision made by the Provost on the basis of the full-time-equivalent students carried by the department of the faculty member to be replaced), and the average semester cost is approximately $10,000 per replacement. These increases are certainly a positive response to the earlier recommendation. Second, although the success rates (the proportion of awards to submissions) differ greatly from the summer grants to the semester leaves, these rates do not tell the whole story. There is an impression among reviewers of the proposals that despite the competition for summer research grants, a dozen or so proposals each year are not strong candidates for funding. The proposals for Semester Research Assignments, which in the beginning of the program were not generally as strong as the summer grant proposals, have been improving recently, in part because some individuals have become eligible to apply for a second time. For this reason, as well as because of the greater importance of semester leaves, it would be a mistake to adjust the funding levels to respond to success rates alone. Third, although the decision to use indirect cost recoveries was an intelligent administrative choice, those funds are available only through the efforts of faculty members who obtain extramural support for their research. This is a principal reason that the College should increase its institutional commitment to individual scholarship.

TABLE 1

SUBMISSIONS AND AWARDS FOR FACULTY RESEARCH LEAVES, 1972-73 TO 1982-83

(Data obtained from Office of Grants and Research Contracts, Development Office, 1974 Self-Study)

	1972-73	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Summer Research Grants							
Applications			61	67	55	56	68
Awards	26	25	32	32	32	32	33
Semester Research Assignments							
Applications			22	28	27	29	29
Awards	3	19	21	21	21	21	21
Sources of Funds for Leaves							
Indirect Cost Recoveries		$112,060	129,899	184,174	189,194	202,166	187,382
Total Expended for Leaves	60,000	143,000	164,000	192,000	216,940	233,400	262,400
Total Private Funds Designated for Research		546,146	202,689	28,514	40,896	22,584	26,460

Organizational Changes.

In an attempt to fix administrative responsibility for research activity, the 1974 Self-Study recommended an increased role for the Committee on Faculty Research and for the Development Office (then in charge of federal funding for research as well as private funding for all other purposes). Specifically, the 1974 Self-Study recommended that the Committee on Faculty Research coordinate the efforts of the various offices that were then involved in research activity, that the Committee publish an annual listing of research activities, that it make policy recommendations regarding research to the President, and that it divide into subcommittees for purposes of preparing proposals for submission to external agencies (especially private corporations and foundations that might be induced to establish research institutes).

Many of these recommendations have been enacted in spirit, if not in letter. In 1977-78, after several years of research funding supervision by the Development Office, the Office of Grants and Contracts was established to coordinate the research activities of the College. The Development Office continues to raise private funds for research-related activities, but as the data in Table 1 show, this is an amount that is steadily decreasing. Indeed, as a proportion of the total amount of money raised by the Development Office, the amount raised for research has declined from a high of 23.8% in 1974-75 to the present 0.5% for 1982-83. So the task of encouraging individual faculty members to submit proposals for external support falls to the Office of Grants and Research Contracts, not to the Development Office or the Committee on Faculty Research.

The Committee on Faculty Research does divide into subcommittees for review of proposals, does make informal policy recommendations to the President, and does administer a $10,000 fund for minor research grants to cover incidental expenses for faculty and graduate student research (another of the 1974 Self-Study recommendations). An annual list of scholarly contributions is now published by the Dean of Graduate Studies for Arts and Sciences (although the list is College-wide).

Importance of Research.

Perhaps the only recommendations from the prior Self-Study that have received virtually no administrative attention are those that dealt with the importance of research to the general intellectual vigor of the institution. The 1974 Self-Study stated that:

> The President and the Board of Visitors should issue a clear statement of policy on research,....(that)...should indicate that support for research will be sought and encouraged; that involvement in research will be included in the evaluation and in the recruiting of faculty; and that a positive atmosphere for the pursuit of research will be explicitly supported (p. 438).

This recommendation for action from the President and Board was accompanied by a recommendation that the faculty and administration attempt to "encourage a sympathetic understanding of the importance of research by the public at large and by the General Assembly in particular" (p. 438). There was also a call for recognition that that facilities and services related to research — audiovisual services, secretarial assistance, stronger electronic and machine

shops, accounting procedures designed to permit multiple uses of equipment — needed substantial improvement.

The *Faculty Handbook* does give research a place in the evaluation of candidates for promotion and tenure, and in the determination of yearly salary increments. In addition, the President's annual reports typically mention the research activities of the faculty, and the contribution those activities make to the overall excellence of the College. There have not, however, been the clear, explicit statements about the importance of research that were envisioned by the 1974 Self-Study. Nor have there been significant overall improvements either in the resources available to support research or in the merit incentives offered to faculty members to encourage research. The program of research leaves is a positive step, to be sure, but only clear leadership from the administration will change the attitudes of those faculty who still believe that research is "something extra" rather than an integral part of their academic responsibilities.

2.   Review of Research Activity

Just how far the College faculty has progressed in the last ten years is indicated not only by the present level of research activity, but also by the manner in which that activity will be reported here. In the 1974 Self-Study the data on research activity covered the five-year period from 1967-72. The publications of faculty members were counted for the period by department, and it was even possible to list individually the 99 research grants that had been received during the period. A comparable publication count is included here, but the figures are only for a single year, and the grant and contract activity can only be summarized. There is no doubt that the College is becoming a more sophisticated and productive contributor to the advancement of knowledge.

Faculty Publication.

Answering one's own questions is informal research, but true scholarly contribution requires public presentation of the knowledge gained or the artistic work created. The exact form of the public presentation will differ from one discipline to another, but in all fields that presentation fulfills the university's responsibility to advance knowledge. In 1982-83 the Dean of Graduate Studies for Arts and Sciences organized an annual list of university-wide faculty publications and artistic contributions, and the data from this list are presented in Table 2.

The list begins with the contract year (August 16) and includes four major categories: books, articles and creative works in journals, talks for which at least the title is published in a journal or in conference proceedings, and exhibits. Two of these categories deserve more detailed comment. The category for books in the table includes the 11-year period from 1972 to 1982, but because this period begins in August of 1972 it does not overlap with the period reported in the 1974 Self-Study (1967-72). Of the 119 books shown in Table 2, 28 were actually published during 1981-82, the one-year time frame used for all of the other categories in the table. The category of exhibits includes prizes, awards, performances, choreography, direction, and set design.

The only direct comparisons with the 1974 data that are possible are in the categories of books, and articles and talks. The definitions for other creative activities are not comparable from one time to the next. For the five-year period

TABLE 2

SCHOLARLY AND ARTISTIC CONTRIBUTIONS 1981–82

(Data from the Annual List of Publications and Other Scholarly

and Artistic Contributions, August 1981–August 1982, and from

the Office of Institutional Research)

Department or School	No. of Faculty[a]	Books 1972–82	Articles 1981–82	Talks 1981–82	Exhibits[b] 1981–82
Anthropology	9	4	10	13	
Biology	19		27	13	
Chemistry	12		11	10	
Classical Studies	4	1	4	1	
Economics	14	1	10	3	
English	28	12	33	9	
Fine Arts	7	2	13	2	10
Geology	5		2	5	
Government	14	8	16	4	
History	24	12	10	12	2
Mathematics and Computer Science	21	1	7	5	
Modern Languages	26	13	8	2	
Music	6	1			2
Philosophy	9		9	3	
Physical Education for Men	6			2	1
Physical Education for Women	10	1	1		4

TABLE 2 (Cont.)

Department or School	No. of Faculty	Books 1972–82	Articles 1981–82	Talks 1981–82	Exhibits 1981–82
Physics	20	2	54	14	
Psychology	14	10	13	15	
Religion	5	2	3	7	
Sociology	13	4	5	4	
Theatre and Speech	8		2	2	11
Business Administration	35	3	17	7	
Education	29	18	16	2	1
Law	22	16	32	9	
Marine Science	(19)[c]	3	64		
Swem Library		5	4		2
Virginia Associated Research Campus			7	6	
University Advancement			1	1	

Notes

a. Only full-time headcount, no part-time, not full-time equivalent.

b. This category also includes choreography, direction, performances, prizes, and set design.

c. Full-time equivalent, not headcount.

reported in the 1974 Self-Study, the 368 faculty members produced 53 books and 1878 other publications (corresponding to the present categories of articlesand talks), or an average of 1.02 other publicatisons per year per faculty member. By comparison, in 1981-82 the 360 faculty members produced 530 articles and talks, an average of 1.47 per faculty member per year. This represents an increase of roughly 40%, a sign that the general research activity of the faculty is improving.

Research Funding.

Because the Commonwealth of Virginia bases its classification of a university in large measure upon the federal funds obtained for sponsored research, the submission of research proposals and the receipt of grant awards provide benefits to the institution that extend beyond the fulfillment of its responsibility to contribute to knowledge. The data on faculty activity regarding sponsored research are presented in two separate tables. The first of these, Table 3, describes the numbers of proposals submitted and funded, categorized by intended funding source, for the five-year period from 1978-79 to 1982-83.

The numbers of submissions and awards presented in Table 3 are for new competing proposals only — amendments to existing awards are not included in these figures. There is one important difference between the figures provided for the main campus and those provided for the School of Marine Science: Records for the former are kept as of July 1 of the first calendar year shown at the top of each column, while records for the latter are kept beginning with January 1. Thus, while every column but the last one represents a full one-year period, the calendar months that are involved are different.

Two comparisons suggested by the data in Table 3 are worthy of comment. First, the faculty of the School of Marine Science (consisting of no more than 58 individuals even if part-time faculty are included in the count) routinely submitted more proposals than did the collective faculties of Arts and Sciences, Business, Education, and Law (which together number 360 counting only full-time people). On a per capita basis this is two proposals a person from Marine Science, and one proposal for every four faculty members on the main campus. The obvious objections to a comparison like this include: (1) some of the Marine Science faculty are dependent upon extramural support for their salaries, (2) the Marine Science faculty teach no undergraduate courses, and (3) few Arts and Sciences departments have the graduate students (and fewer still have the doctoral students) necessary to bring the research enterprise to a "critical mass." Each of these objections states an obvious truth. But there remains the equally obvious truth: Many members of the Faculty of Arts and Sciences, and selected faculty members in Business, Education, and Law nonetheless submit research proposals on a level comparable to the Marine Science average. More members of the collective faculties found on the main campus must be encouraged to shoulder their share of this professional and institutional responsibility.

The second comparison suggested by the data in Table 3 has to do with change over time. During the five-year period covered by the table, the number of proposals originating in the School of Marine Science has increased substantially, although the overall dollar amounts (shown in Table 4) have not increased proportionally. By contrast, the number of proposals originating in the Faculty of Arts and Sciences and the Schools of Business, Education, and Law have remained relatively constant during the five-year period. Particularly since

during the five-year period there have been 105 separate semester research leaves awarded to members of these main campus faculties, and there have been in excess of 150 summer research grants awarded (though these do contain some multiple awards to single individuals), it is distressing to see no corresponding increase in the attempt to obtain outside support for research. Again, some institutional incentives must be developed that will increase the pool of faculty members who seek external funding. One of the reasonable possibilities is to make a second summer grant award, or more importantly, a second Semester Research Assignment more highly contingent not only on publication but also on attempts to secure external funding. At many institutions these internal research funds are explicitly considered "seed money" designed to produce a program of research or artistic contribution that can then sustain itself on external funds. At William and Mary, however, the summer and semester research leaves are regarded more as a deserved fringe benefit than as the impetus needed to make one's research externally competitive. Changing this attitude is an important task that remains.

The actual dollar amounts for grants and contracts awarded during the period from 1978-79 to 1982-83 are shown, categorized by source of funds and academic division, in Table 4. Before discussing these awards, a few words of caution are in order. First, the award data are recorded differently by the Office of Grants and Research Contracts and the School of Marine Science's *Special Scientific Publication* No. 114, from which the Marine Science data were taken. At the main campus the numbers of awards include amendments to existing grants (that received scientific review in a prior year) as well as awards made following an initial scientific review. Similarly, the amounts recorded by the Office include only the funds actually transferred to the College during the year shown (so, for example, an award from the National Science Foundation for 24 months would be listed in its entirety during the award year, while an NSF grant approved for 36 months would appear as three separate awards in successive years). By contrast, because the data from Marine Science were obtained from a listing by proposal, rather than from financial records, both single-year and multiple-year awards appear only during the year of the proposal. These differences render any year-by-year comparison meaningless, but over the five years shown in the table the differences become substantially less important.

Second, there are several omissions made for purposes of comparibility that still deserve to be noted. Foremost among these is the College's success in obtaining a $500,000 National Endowment for the Humanities challenge grant. This is a highly significant increase in external funding for the humanities at the College, but it does not appear in the table because the account it represents is maintained by the Development Office, not by the Office of Grants and Research Contracts. There are a number of grants from federal agencies for student aid and for direct awards to faculty members in the humanities that do not appear in the table because they are not technically awarded in response to competitively submitted research proposals. Likewise, there are occasional grants (a grand total of 10 across all funding sources for the five-year period) awarded to combinationas of academic divisions, and there are 23 awards across all funding sources for the five year period that do not involve the academic divisions listed in the table. These funds are for institutional components such as the library, Ash Lawn, and the Muscarelle Museum, and also do not represent competitive research in the usual sense. By omitting these atypical cases, the data in Table 4 become comparable both to the information in the 1974 Self-Study and to the information available from various national organizations.

TABLE 3

GRANT PROPOSALS SUBMITTED AND FUNDED 1978-83

(Data obtained from the Office of Grants and Research Contracts

and from School of Marine Science Special Scientific Report No. 114)

Funding Source and Action	1978-79	1979-80	1980-81	1981-82	1982-83
Recorded by Office of Grants and Research Contracts[a]					
Federal Government					
Submitted	54	60	62	46	62[b]
Funded	35	41	39	35	38
Success Rate	.65	.68	.63	.76	
State Government					
Submitted	15	12	15	11	14
Funded	7	8	13	10	12
Success Rate	.47	.67	.87	.91	.86
Private Agencies					
Submitted	13	18	21	20	23
Funded	9	9	12	12	14
Success Rate	.69	.50	.57	.60	.61
Recorded by School of Marine Science[a]					
Federal Government					
Submitted	55	46	85	91	73[b]
Funded	35	31	43	54	42
Success Rate	.64	.67	.51	.59	

TABLE 3 (Cont.)

Funding Source and Action	1978-79	1979-80	1980-81	1981-82	1982-83
State Government					
Submitted	13	23	21	15	15[b]
Funded	10	19	10	10	6
Success Rate	.77	.74	.48	.67	
Private Agencies					
Submitted	23	15	11	15	17[b]
Funded	17	11	6	7	9
Success Rate	.74	.73	.55	.46	

Notes

a. College records begin with July 1, Marine Science records with

    January 1 of first year listed in each column heading.

b. No success rates will be computed for the 1982 proposals, because

    some are still pending.

Finally, a caution should be noted about the awards derived from agencies of state and local government. For the data recorded by the Office of Grants and Research Contracts, awards from "state agencies are primarily new competing awards from agencies of the Commonwealth of Virginia. By contrast, for the data concerning Marine Science, the funds received consist in the majority of Commonwealth matching funds that must accompany grants made by certain federal agencies. In addition, because of its unique expertise on the Chespeake Bay, the School of Marine Science receives awards not only from Virginia, but also from Maryland, North Carolina, and even New York.

Given all of these cautions, what conclusions can be drawn from the data in Table 4? Perhaps most obviously, the federal government is the principal source of support for sponsored research. So while the staff of the Development Office should be aware of the sources of private funds, the staff of the Office of Grants and Research Contracts should be as familiar as possible with the funding policies of the federal government. Another obvious conclusion is that on the main campus most of the activity in sponsored research originates with members of the Faculty of Arts and Sciences. Because of its greater collective experience, not to mention its greater numbers of faculty members, this Faculty should receive the most attention (either in the form of carrots or sticks) in any attempt to make the university as a whole a more productive seeker of support. On the other hand, it is also clear that the Schools of Business, Education, and Law have not been nearly as active in the search for external support as they should be.

One conclusion to be drawn from the data in Table 4 is not nearly so obvious. Despite federal budget cutbacks, the average awards on successful proposals do not seem to be decreasing. Furthermore, the number of awards (like the dollar amount) has remained relatively constant across the years. So it is *not* the case that the funds are flat either because more researchers are getting smaller awards, or because many fewer investigators are being supported with individually higher awards. What these data mean is that two factors most likely to influence a researcher's decision to seek funding — the agency success rate, and the ability to obtain an award sufficient to accomplish the research — have not changed for the worse in the past five years. That these external pressures have not changed makes it more reasonable to believe that concerted institutional efforts to increase the numbers of submissions from all faculties would make a considerable difference in the College's overall competitive position. It is to that position, indicated by comparisons to other doctoral granting institutions, that we now turn.

B. NATIONAL COMPARISONS

The College of William and Mary does not fit easily into any of the traditional categories for classifying universities. It is one of six doctoral granting institutions in the Commonweealth of Virginia, the others being George Mason University (GMU), Old Dominion University (ODU), the University of Virginia (UVA), Virginia Commonwealth University (VCU), and Virginia Polytechnic Institute and State University (VPI). Of these, only George Mason University and the College have neither a medical school nor an engineering school — the two institutional components most heavily involved in sponsored research. Nationally, William and Mary is considered a "Category B" institution

TABLE 4

AWARDS OF GRANTS AND CONTRACTS BY ACADEMIC DIVISIONS 1978-83

(Data obtained from the Office of Grants and Research Contracts,

and from School of Marine Science Special Scientific Report No. 114)

Academic Division	1978-79	1979-80	1980-81	1981-82	1982-83
Awards from Agencies of the Federal Government					
Arts and Sciences					
Number	26	41	33	35	29
Amount	$886,794	1,512,626	1,405,760	1,562,305	1,422,227
Business					
Number		1	1		
Amount		4,000	4,000		
Education					
Number	2	1	1	2	
Amount	96,759	64,000	42,299	14,540	
Law					
Number	1	1	1	2	1
Amount	1,000	4,750	3,000	33,860	3,600
Marine Science					
Number	35	31	43	54	42
Amount[a]	5,484,581	2,454,710	2,720,154	3,740,334	1,842,345

TABLE 4 (Cont.)

Academic Division	1978–79	1979–80	1980–81	1981–82	1982–83
Awards from Agencies of State and Local Government					
Arts and Sciences					
Number	3	3	5	6	12
Amount	$38,984	112,235	42,401	75,078	159,015
Education					
Number	1	2	1	3	3
Amount	4,900	33,960	7,973	38,460	50,653
Marine Science					
Number	10	17	10	10	6
Amount[b]	734,665	1,114,925	892,026	1,226,679	315,384

Awards from Private Corporations and Foundations					
Arts and Sciences					
Number	8	10	9	10	10
Amount	68,016	99,026	65,960	122,024	295,572
Business					
Number	2	1	1	2	
Amount	15,500	10,415	610	3,200	
Education					
Number	2	1	1	3	
Amount	5,742	1,500	7,055	17,468	2,000

TABLE 4 (Cont.)

Academic Division	1978–79	1979–80	1980–81	1981–82	1982–83
Law					
Number	1		2		2
Amount	63,155		100,930		19,120
Marine Science					
Number	17	11	6	7	9
Amount	343,938	143,202	101,924	155,593	268,841

Notes

a. Amounts for Marine Science for federal funds are totals of both single-year and multiple-year awards, listed in the year of the proposal.

b. Amount of state and local funds for Marine Science includes total of grants for proposals submitted directly to state and local government plus Virginia maching funds for grants submitted to Federal agencies. The latter typically comprises more than half of the amount shown for awards from state and local government.

(6,000-12,000 full-time equivalent students) by the American Association of State Colleges and Universities (AASCU), as a "four year doctoral" institution by the American Council on Education's Higher Education Panel (HEP), and as a "small college" by the National Science Foundation's special research support program (fewer than 20 doctoral degrees awarded per year in science and engineering). Very few of the other colleges and universities in William and Mary's category have the quality of faculty, the deserved national reputation (especially in the doctoral-granting departments), or the research aspirations inherent in the College's mission statements. What William and Mary aspires to be, in fact, is a "major research university" — but only in a very few selected disciplines. And how well William and Mary appears to be doing its job depends to no small degree on which national comparison ("four year doctoral" or "major research university") is chosen as the standard. This caveat must be kept in mind in the coming comparisons.

1.   Concentration on Basic Research

The only federal granting agency charged specifically with the support of basic research in all disciplines of the sciences is the National Science Foundation. Other federal agencies such as the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the Department of Energy (DOE), the Interior Department's National Park Service (NPS), and components of the Department of Defense (DOD) also support basic research on topics relevant to their individual missions. The National Endowment for the Humanities is an important source of support for basic research in humanities, the National Endowment for the Arts supports a variety of creative endeavors, and a number of major private foundations also contribute to the support of basic research. Comparative data across universities are, however, only readily available for funds from NSF, so if one's objective is to document a university's contribution to the advancement of knowledge for its own sake, the funds that institution receives from NSF will be the single best index.

Data for the NSF funds received by Virginia's doctoral granting institutions are presented in Table 5. The dollar amounts should be interpreted with caution, because the most recent available data are from 1979, but there is no reason to believe that the relative proportions within any university have changed dramatically since then. Although its overall dollar amounts are small, the College's proportion of NSF funds is the highest in the state. Universities with hospitals receive most of their research funds from agencies concerned with health, Old Dominion University's funds come primarily from NASA, George Mason University's funds derive principally from NIH, and because of its land-grant status nearly half of Virginia Polytechnic Institute and State University's funds come from the Commonwealth. So, although there is room for improvement in the College's overall competitive position, there is no need for a redirection of its research efforts. Concentration on basic research is consistent with the College's institutional goals and makes it a credit to the Commonwealth.

TABLE 5

SOURCES OF RESEARCH SUPPORT FOR VIRGINIA DOCTORAL-GRANTING INSTITUTIONS

(Data obtained from Research Activities in Virginia's Public Institutions of Higher Education, State Council of Higher Education for Virginia, 1979.)

	W&M	GMU	ODU	UVA	VCU	VPI
Major Source[a]	NSF	NIH	NASA	DHEW	NIH	VA
Percentage provided	36.2	47.4	71.8	52.6	82.5	48.2
NSF Grants Only						
Percent	36.2	---	3.9	14.2	---	6.5
Dollars[b]	.273	---	.091	2.409	---	1.542

Notes

a.   Each university's major source of research funds, as a proportion of the total research expenditures by the university for 1979. Agencies are the Department of Health, Education, and Welfare (DHEW, now the Department of Health and Human Services, DHHS), the National Aeronautics and Space Administration (NASA), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Commonwealth of Virginia (VA).

b.   Dollar amounts are for the latest year available, 1979, and are expressed in millions.

2.   National Standing

Despite its concentration on undergraduate education, and its relatively small size, the College aspires to a national reputation both for its liberal artsundergraduate offerings and for its several graduate programs. At the graduate level the College offers the MA or MS degree in 12 fields in Arts and Sciences, and offers masters degrees in Business, Education, Law, and Marine Science. According to a 1983 report of the Graduate Studies Committee of Arts and Sciences, the MA and MS programs in Arts and Sciences have produced a total of 618 degrees in the ten years between 1973 and 1983. The College offers doctoral degrees in three disciplines in Arts and Sciences — History, Physics, and Psychology — in Education, and in Marine Science. For the period from August, 1982 through May, 1983, 14 doctorates were conferred in Arts and Sciences (five of which were in the consortial PsyD program jointly administered by the College, Eastern Virginia Medical Authority, Norfolk State University, and Old Dominion University), 28 doctorates were conferred in Education, and five were conferred in Marine Science.

How well the College has met its goal of achieving national standing is quite difficult to gauge. At the undergraduate level the College's reputation can be indicated by its selectivity in admission and by the overall SAT scores of its entering students, because comparable figures for other institutions are readily available. At the graduate level, the corresponding admission and GRE data are useful only for comparisons among programs within the College, primarily because there are so few doctoral programs: The admission and GRE score data are more descriptive of the particular academic disciplines involved than they are of the College as a graduate institution. Another potential criterion of a national reputation, the extent of scholarly publication, is similarly flawed for a university that does not offer a complete range of graduate programs. The data shown in Table 2, for example, reveal that the Arts and Sciences faculty in doctoral departments produced an average of 2.5 publications apiece, while those in the non-doctoral Arts and Sciences departments produced an average of 1.5 apiece, but neither of these figures is particularly useful for national comparisons. Any such comparison would require a definition of "publication" that was consistent from one university to the next, a standard practically impossible to achieve.

Perhaps the most clearcut comparisons that can be drawn between the College and its national peers lie in the area of success in sponsored research. At the very least, the criteria — proposals submitted and funded, dollar amounts received — are precisely defined. These comparative figures are presented in Table 6, which compares figures from William and Mary with two different standards. The first of these is the comparison to science and engineering departments in doctoral granting universities, and is based on the American Council on Education study of young faculty in doctoral institutions. The rate for submissions per faculty member is nearly a research proposal per faculty member per year, a standard typical of the level of activity in the doctoral institutions that William and Mary would choose to emulate, at least on the graduate level. The second comparison is to the average for the 20 of 24 American Association of State Colleges and Universities "Category B" institutions. These are institutions with an average of 501 faculty members, 7,627 undergraduate students, and 826 graduate students. These Category B

TABLE 6

GRANT PROPOSAL SUBMISSIONS AND FUNDING--NATIONAL COMPARISONS

(Data obtained from the American Association of State Colleges and Universities Office of Federal Programs, the American Council on Education Higher Education Panel Report No. 43, and the Office of Grants and Research Contracts.)

	Submissions per Faculty Member	Total Submitted in 1981-82	Number of Awards	Success Rate	Dollar Amount
William and Mary	.22[a]	77	57	.74	1,610,705
Other Doctoral Science & Engrg.	.88[b]			.57[c]	
Other Category B[d]	.28	141	69	.49	1,836,736

Notes

a.   This figure is total submissions, including amendments to existing grants (so that it will be comparable to the figures for the other Category B institutions) divided by total full-time headcount faculty (excluding Marine Science).

b.   This figure is submissions in 1976-77 by members of science and engineering departments (Biochemistry, Biology, Botany, Chemical Engineering, Chemistry, Economics, Electrical Engineering, Geology, Mathematics, Microbiology, Mineral Engineering, Physics, Physiology, Psychology, Sociology, Zoology) in selected universities that grant doctoral degrees.

c.   This figure is the award/submission ratio for 1976-77 for faculty described in Note b.

d.   These data, obtained from the American Association of State Colleges and Universities, are directly comparable to the William and Mary figures.

institutions give teaching their highest priority, and 50% of them rank research activity *third* among teaching, research, and public service. Roughly half of the Category B institutions have an associated engineering school, but only two have associated medical schools. Only a third of these Category B institutions award the doctoral degree, and nearly half receive most of their federal funds from the Department of Education, primarily for the purpose of curriculum development; the National Science Foundation is mentioned as the principal source of funds only two or three times (that, of course, includes William and Mary as one of the two or three). So while the College is similar in size to many of the Category B institutions, most of them do not make the claim to research eminence inherent in the institutional decision to grant doctoral degrees.

What do the data in Table 6 say about William and Mary's national position? First, it should be noted that our funding success rate is significantly larger than that of the other Category B institutions, and the dollar amount of research funds William and Mary receives, given its smaller faculty, is also commendable if the Category B institutions are used as the standard of comparison. On the other hand, if William and Mary's faculty had submitted the proposals per faculty member that characterized the science and engineering faculties of other doctoral granting institutions, 1981-82 would have produced over *three hundred* proposals, instead of the 77 that were submitted. Indeed, if only the "science and engineering" faculty of William and Mary had achieved this level of submission, there would have been 100 proposals instead of the 77 submitted. If the College is going to grow into the eminence to which it aspires as a doctoral institution, and if it is going to compete within Virginia with the University of Virginia and Virginia Polytechnic and State University, both of which employ sufficient physical, environmental, and social scientists to place them in the top 100 doctoral granting institutions, it is going to have to make up in individual productivity what it will continue to lack in sheer size. William and Mary must not only embrace the more stringent national standards for research productivity, it must conduct its institutional life in a manner that will encourage the achievement of those standards. Specific recommendations to accomplish these ends appear in the final section of the chapter.

C. PROJECTIONS AND RECOMMENDATIONS

Most national studies conclude that within the next ten years the undergraduate enrollment in the country's colleges and universities will decline by some 30% from its present levels. Given the College's highly selective current admissions policies, it is unlikely that William and Mary will experience an actual drop in enrollment; rather it will most probably respond to the decreases in the college-age population by changes in admission standards that will keep enrollments constant. But whatever the response may be, it is clear that those in the Legislature who support public education will be expecting more from colleges and universities than the instruction of undergraduates, and more, for that matter, than the instruction of graduate and professional students.

When the dollars become scarce, the question "What *else* are you doing for us?" will begin to be asked. It is at that point that the research universities will be distinguished even more clearly than they presently are from the institutions that only teach. There will be the institutions on the cutting edge of technological

change — whether their contributions are in the technology itself, the social consequences of technological change, the study of long-held cultural values that should be brought to bear on the decisions to be made, or the business, educational, or legal ramifications of such change — and there will be the institutions that will have to be content with merely communicating the discoveries made by others. If William and Mary is to retain its commitment to excellence, it must be among the former. But this goal cannot be accomplished without increasing the College's commitment to scholarship, both in the form of publication and in the form of external support for faculty and student research. This final section presents the Committee's recommendations for ways to enhance the institutional commitment to research. The recommendations are grouped into three major categories.

1. Enhance the Institutional Ability to Compete

Even in the AASCU Category B institutions, most of which might not have the national aspirations for excellence as a doctoral granting university that William and Mary has, 55% of the grants offices provided typing services, 85% provided duplicating services, 65% provided collating, 70% packaged proposals and mailed them, and 65% provided courier services to meet short deadlines. Over half of the grants offices made use of word-processing equipment, 70% provided grants workshops for faculty, and staff from the office spent, on the average, 23 days a year either in Washington, D.C. or in the state capital on grant-related activities. This level of service to the institution was provided with an average staff of 1.7 professionals and 1.9 clerical workers, supplemented by an average of 1.5 student assistants. Given the present burden on departmental facilities (compounded by the roughly 30% decrease in maintenance and operations funds during the last several years), a few important changes in the Office of Grants and Research Contracts and in the departments and schools might substantially increase the institution's ability to compete for research funds.

1. The Office of Grants and Research Contracts should increase the level of communication between researchers and representatives of funding agencies. This could be accomplished first by workshops conducted for faculty and graduate students by staff of the Grants Office, in conjunction with members of the faculty who are either (1) successful grantees, (2) members of granting agency advisory panels, or (3) former agency officials. As an alternative, the workshops could be led by officials of federal granting agencies who had been invited to campus specifically to describe their research programs. The second way that communication between researchers and the funding community could be enhanced would be for staff of the Grants Office to make regular visits to the funding agencies, carrying with them examples of research projects for which faculty members are seeking support.

2. The level of proposal services provided to faculty members should be dramatically increased. Each department or school should have word-processing capability reserved for faculty members' research publications and proposals, even if this is limited to terminals of the NAS or PRIME computers. The Office of Grants and Research Contracts should have its own terminals, and should also have a letter-quality printer on which a proposal produced in a department or

school could be printed. Ultimately, some of the additional proposal services noted above, as well as travel funds for faculty members seeking support and additional secretarial time (at the departmental level), would also be beneficial.

3. Records of submissions should be kept, on the computer, in two different forms. The present financially-based records of awards and dollar amounts should be continued. In addition, there should be a proposal-based record that could be used to identify success rates and sources of support sought (All actual proposals should also be retained for archival purposes.).

4. The College should, in concert with other Virginia colleges and universities, make every effort to retain locally 100% of the indirect costs associated with sponsored research. At the present time 30% of the indirect costs associated with research conducted at the College are immediately transferred to a central account in Richmond, to return to the College only as part of other appropriations. By contrast, 85% of the other colleges and universities in AASCU Category B are able to retain 100% of indirect cost recoveries locally. The College's present indirect cost rate is 53.11% of salaries and wages, an amount not substantially different from the Category B average of 49.1%. Changing to 100% local from 70% local would provide many of the research-related funds necessary to implement our recommendations.

2. Provide Incentives to Individual Faculty

Enhancing the institutional capability to compete will make no difference if there is not broader faculty participation in research. The 1981-82 list of publications reveals that there are a few faculty members whose personal publications outnumber those for several other *departments* It is possible to combine research, sponsored or not, with excellent undergraduate, graduate, or professional teaching, and more members of the faculties must be encouraged to do so. The attitude that research is "something extra" rather than part of one's normal academic responsibilities can only be changed through clear leadership from above.

5. The *Faculty Handbook* states that "criteria for etention, promotion, award of tenure, and evaluation of a facutly member include...significant contributions to his or her field through research and scholarly or artistic activity" (p. 67). The President, the Provost, and the Deans should make it clear that they consider research activity, no less than effective teaching, a normal responsibility of faculty members, a responsibility to be taken seriously in evaluations.

6. In departments and schools with graduate programs, and especially in research departments or schools, there should be higher expectations for research productivity than in departments without graduate programs.

7. Whenever the Faculty Research Committee considers either (1) a *second* or succeeding request for a Semester Research Asignment or (2) a *third* or succeeding request for a Summer Research Grant, it should make any award contingent upon the applicant's demonstration that he or she has made a serious proposal to an external agency (unless no such private or public agency exists) for support of the research initially funded by a College leave. Those whose research has benefited from prior College leaves have the greatest responsibility to contribute to the indirect cost recoveries that fund the internal gram

program. During the next ten years this program should be expanded, adding at least one Summer Research Grant every year and at least one Semester Research Assignment every other year.

8. Department Chairs and Deans of Schools should make it clear that their personnel evaluation procedures will recognize and encourage research. They should, as some already do, restructure their limited resources in ways that will promote research. Teaching schedules, travel and equipment funds, and priority in access to secretarial services should favor those who are fulfilling their responsibilities to conduct research as well as their responsibilities to teach undergraduate and graduate classes.

3. Increase Public Awareness of Research Contributions

The College currently publishes lists of grant awards in the *William and Mary News*, publishes an annual list of faculty scholarly contributions, and includes the recipients of Semester Research Assignments and Summer Research Grants in the President's annual reports. These public acknowledgements of research are commendable and should be continued. But they should be supplemented.

9. Three awards for research should be established. The first, for faculty members, would be the yearly equivalent of the Jefferson Teaching Award, and should be given for the most significant research contribution of the year. The second award, for graduate and professional students, should be for the best dissertation, thesis, or equivalent research paper of the year. The third, for undergraduate students, should be an award for the best Honors thesis of the year. Establishing all three awards at the same time would indicate not only that the College considers research as important as teaching and obtaining high grades, but also that original scholarship should not be the exclusive province of the faculty.

10. A publication devoted to research should be developed. This could be the institutional version of popular magazines on scientific and intellectual topics. In each issue a few faculty and student research projects should be described in detail, but in a manner designed for the general public. This publication should also include grant lists, and one of the several issues each year could be devoted to the formal report of the Office of Grants and Research Contracts. Properly and attractively done, this publication could be used to communicate the importance of research at the College not only to those in the institutional community, but also to the legislature, to potential donors contacted by the Development Office, and to the general public.

In the years since the last Self-Study the College has made considerable progress in the institutional support for research, especially in the funding of research leaves. But a great deal more remains to be done. By enhancing the institutional capability to compete, by providing direction and incentives to faculty, and by increasing the public awareness of research, the College can help to insure its future excellence in the Commonwealth.

XII.
COMPUTER RESOURCES

INTRODUCTION

Computer technology has grown at a tremendous rate over the past decade, and the use of computers has spread to almost every walk of life. It will not be long before almost every educated person will be required to have a working knowledge of computers and their applications. Many elementary and intermediate schools are beginning to integrate computers into their programs, and computer science courses are becoming well established in most high school curricula. The *Chronicle of Higher Education* (Feb. 1, 1984) reports that "well over a third of this year's college freshmen have written a computer program in the past year — compared to only 27 percent of last year's class." With the ever increasing emphasis put on computer technology in today's world, the number of students entering college with at least some experience with computers will continue to increase. These students expect, if not demand, to have computing facilities available to them at the college they attend. In addition, administrative duties can be handled more efficiently and less expensively using modern computer hardware and software, and an active research program demands state-of-the-art computing facilities. It is, therefore, essential that the College of William and Mary keep abreast of the rapidly changing field of computer technology and incorporate the advances into its teaching, research, and administrative functions.

It is impossible to predict where the College should be ten years from now in respect to computer needs — so rapidly is the field of computer technology advancing. It is hoped, however, that this report will provide some insight into the present needs as well as the needs for the next few years. Data for this report were collected by surveying the faculty, administrators, and students of the College. Our Committee conducted surveys of the administrators and students in March 1984 to gain insight into their respective needs. In addition, the results of surveys conducted in March by two other Committees, the Academic Computer Users Committee and the Ad Hoc Committee for Administrative Computing, were used in this report. David A. Evans, Director of Computing, School of Marine Science, and Fredric J. Lederer, Associate Dean of Administration, School of Law, provided sections on computing at their respective Schools. Finally, numerous individuals, both solicited and unsolicited, expressed their opinions on computing needs to our Committee.

It should be pointed out that the student survey was not a random survey of all students. Groups of students (in many cases classes) were chosen to reflect the opinion of computer users and nonusers, upper and lower classmen, and undergraduate and graduate students. Also, the Academic Computer Users Committee did not survey faculty members directly, but rather sent surveys to

department chairmen and deans instructing them to survey their respective departments or schools and complete the survey form.

A. HISTORY AND PRESENT STATUS OF COMPUTING AT WILLIAM AND MARY

1. Main Campus

At the time of the last Self-Study, the College had only an IBM 360/50 computer. Almost all work done on this machine was batch processing, and academic use dominated administrative use. The computer also served as the main computer for a number of smaller colleges in Virginia.

For the academic year 1975-76, the IBM 360/50 was replaced with an IBM 370/145 computer. This was in turn replaced at the start of the 1976-77 academic year by an IBM 370/158. The latter served as the College's only computer until 1981. Again, the machine was used primarily for batch processing and primarily for academic work.

Academic users were dissatisfied with the batch orientation of the 158 and with the perceived "unfriendliness" of its command language. Administrative users were also suffering from unmet needs. Together these dissatisfactions resulted in the creation of an Ad Hoc Computer Planning Committee, headed by Professor Franz Gross, which issued its report in November 1979 (hereafter referred to as the Gross Report). The report contained 17 recommendations covering four broad areas: (1) the organization of the Computer Center, (2) the organization and functions of the users committees, (3) computer hardware, and (4) the appointment of a task force for acquiring new computer hardware. Most of the recommendations of the Gross Report have been implemented and the report has served as *the* plan for computing since that time.

The goals set by that report are shown as the last column of data in Table 1. The other columns represent:

Nov. 79 — Report of the Gross committee
Aug. 81 — Acquisition of first Prime computer
Aug. 82 — Acquisition of second Prime computer
Aug. 83 — Replacement of Prime 750 with an 850
Aug. 84 — Current configuration

The rows represent various measures of computing power and availability. The current configuration consists of an NAS 6650, a Prime 9950, a Prime 850, and a Prime 750. The NAS 6650 is referred to as the IBM compatible system, since it is plug-compatible with the IBM computer it replaced.

One of the major concerns of the Gross committee was the acquisition of a computer for interactive, academic use. The committee explicitly designated a new machine that would be more "user friendly" than the existing IBM computer. The Prime computers so acquired apparently fit this stipulation as evidenced by the rapid growth in the use of these machines (Table 2). For the 1983-84 academic year 3175 students and 163 faculty members used the Prime computers. Note that CPU minutes is simply one of several measures of how much work the computer is performing.

Table 3 shows a slight decline in the academic use of the IBM computer. The sum of the administrative and academic categories of each of batch

TABLE 1

COMPUTING AT WILLIAM AND MARY

	Nov 1979	Aug 1981	Aug 1982	Aug 1983	Aug 1984	Plan 1986
Computer Power (IBM 370/158 = 1)						
IBM	1	1.00	1.00	1.00	2.70	2
Prime	0	1.46	2.92	4.12	7.78	1-2
Total	1	2.46	3.92	5.12	10.48	3-4
Printer Capacity (lines per min.)						
IBM	1650	2700	2775	2755	3040	
Prime	0	300	900	1000	1800	
Total	1650	3000	3675	3775	4840	2700
Disk Capacity (billions of characters)						
IBM	2.2	2.6	2.6	2.6	8.3	
Prime	0.0	.9	1.2	2.1	3.3	
Total	2.2	3.5	3.8	4.7	11.6	6.0
Remote Stations	1	1	2	3	3	3
Terminals: Primarily Student Use	14	36	96	120	146	107
Terminals: Primarily Faculty Use					71	90	---
Terminals: Administrative Use	2				10	15	25
Terminals: Computer Center	2				14	16	3
Terminals: Administrative Data Systems	7				11	13	10
Dial-up Lines					18	27	---
Microcomputers: Student (Center Owned)					0	24	0
Microcomputers: Administration					5	17	0
Microcomputers: Department						42+	0
Word Processors					5	6	30

TABLE 2

SUMMARY OF PRIME USE

	1981/82	1982/83	1983/84
Overall Statistics			
Student users	833	2330	3175
Faculty users	72	157	163
Total users	905	2487	3338
Departments (by course)	22	22	
Majors (by individual)			all
Averaged Individual Statistics			
Number of sessions	66	97	104
CPU minutes	56	52	56
Session length (in min.)	38	24	18

TABLE 3

SUMMARY OF IBM USAGE

	1980/81		1981/82		1982/83		1983/84	
	% CPU	% Cost	% CPU	% Cost	% CPU	% Cost	% CPU	% Cost
Admin. Use								
Batch	12	21	15	26	19	34	21	29
Interactive	14	15	15	16	25	25	39	37
Total	13	19	15	24	20	26	24	30
Academic Use								
Batch	88	79	85	74	81	66	79	71
Interactive	86	85	85	84	75	75	61	63
Total	87	81	85	76	80	74	76	70
Academic Use without Phys, Chem								
Batch	74	64	60	49	56	40	35	29
Interactive	84	81	78	78	52	54	35	37
Total	77	69	67	57	55	43	35	31

interactive, and total adds to 100%. CPU usage is one measure of how much it "costs" to service a user; the other column shown (% cost) is based on the total billing charge, including the cost of printing, etc.

Most academic use of the IBM computer is by users of the SAS statistical package and by those users requiring a large number of CPU minutes per program executed (so called "number crunchers" as in Physics and Chemistry). An ordinary or "non-number cruncher" user usually requires less than a minute of CPU time per program execution. Since SAS has been ordered for the Primes, SAS users may also disappear off the IBM computer.

The third set of rows shows the amount of academic use of the IBM computer versus administrative use when the number crunchers are excluded. This seemed reasonable since the number crunchers are few in number and a single Physics user can significantly raise or lower the total academic percentage. This set of figures shows a significant drop in academic usage.

Both the IBM computer and the Prime computers were saturated for the 1983-84 academic year. System response time was very slow, even for trivial requests. There were often waits of an hour of more to get a terminal, particularly for the Prime computers. Many students were forced to work after midnight in order to be sure of both getting a terminal and receiving adequate response time. Some teachers were forced to eliminate or severely scale down projects using the computer. This situation necessitated replacing the IBM 370/158 computer with the more powerful, plug-compatible NAS 6650. Similarly, the Prime system was enhanced by adding a Prime 9950. It is hoped that this upgrade will provide enough computer power to handle the present need. It should be pointed out, however, that the computer usage on the Primes has been growing at the rate of an entire new Prime 750 per year.

2. School of Marine Science

The Computer Center at VIMS is designed to serve the needs of a community of students and scientists engaged in basic and applied research in marine science. A computer center was in existence at the Institute well before the administrative integration of VIMS with the College. The separate budgetary status of VIMS and the different needs of a research institute are major factors considered in continuing this state of affairs. The Computer Center Manager reports to the Associate Director for Finance and Administration at the Institute.

The Gross Report did not consider the computing needs of VIMS in any great detail. This was not a negative oversight; at the time, VIMS was not administratively part of the College and use of the College computing facilities was classified as "external use." In addition, a committee was at work at the same time at VIMS considering future plans for computer services. Conversation between the two committees resulted in agreement that VIMS was better able to deal with its own needs even after the integration.

In April 1981 a Prime 750 computer was installed at VIMS. This machine is a time-sharing "super-mini" computer capable of serving up to 128 terminals and having adequate power for the "number crunching" work which forms a large part of VIMS computer activities. The period since installation has been one of continual growth as more people in the Institute discover the uses of a computer in their work. The Prime 750 was upgraded to a Prime 850 in July

1983. This was in anticipation of an extra load being placed on the computer by the addition of a number of administrative systems. Other improvements have been made to the original system. Initially, a maximum of 32 terminals could be supported; this limit has been increased to 80 by the purchase of more circuit boards. Likewise, the initial disk storage capability of 380 megabytes has been increased by the addition of more disk drives to 980 megabytes. However, with the number of users increasing and with some research projects in progress which will produce large quantities of data, adequate disk storage capacity will remain a problem.

Access to the computer through terminals is available to all students, faculty, and staff of the Institute for 24 hours a day, seven days a week with the exception of scheduled down time for system maintenance and back-up.

A considerable increase in use occurred after a word-processing package, MUSE, was installed in mid-1983. This package offered all the features of a sophisticated word-processor and could be used from any video terminal. As a result, theses, papers, reports, and memos are now produced routinely by students, faculty, and secretaries. A very positive result from this is that people who ordinarily would not use video terminals and a computer system have become quite at ease with the "new technology." It is probably this package which has been most responsible for combating the "computer phobia" from which many suffer.

The use of computer graphics for the presentation and interpretation of data is recognized as being of considerable importance. Consequently, the Institute possesses a small number of graphics terminals and a plotter for the production of graphics together with associated software and systems for their operation.

The Computer Center presents an introductory course in use of computer systems and two courses in more advanced techniques of programming and data management. Short courses in specialized topics are also given as the need arises.

With the completion of Watermen's Hall, the Computer Center moved from cramped quarters with poor environment control into more spacious, climate-controlled ones.

While the Computer Center is administratively separate from the one on the Williamsburg campus, data can be transmitted between the two computer systems over the public direct dial network or the SCATS network. It is anticipated that increased use of this capability will be made for financial and administrative data.

Microcomputers of various types have been acquired by departments for use in special projects. Since purchase requests for computer equipment are routed through the Computer Center, it is ensured that the requested equipment is compatible with interaction with the main system. It is expected that microcomputers will continue to appear in laboratories and offices and in the field. In addition, the Computer Center, in collaboration with other departments, is designing a series of microprocessor-based data acquisition devices for use in the field.

The Computer Center is currently manned by eight people, of whom two are half-time student assistants. This staffing is minimal. In particular a great need is felt for technical help in the construction of hardware and the maintenance of terminals and communications devices. These tasks are at the moment undertaken by a person at the level of Computer Systems Engineer who should more profitably be engaged full-time in systems development of field

data acquisition systems. All the staff are available to users for consulting with problems involved with all aspects of computer use.

Computing at VIMS has received good support from the central administration since the acquisition of the Prime system. This is evidenced by the gradual but consistent growth. It is recommended that this support continue, and at a greater level. The lack of technical support in the Computer Center is noted and attempts should be made to fund a new position. Some further recommendations for future development are presented below.

In common with the rest of the College, computer use at VIMS is increasing. thus, the service provided cannot be static but must tract the trend in usage. It must be recognized that upgrades in hardware and software must be provided to accommodate the increasing needs. Adequate funds should therefore be made available to achieve this.

The graphics capabilities are at present minimal. There is, in particular, no color capability either with graphics terminals or with hard copy plotters. It is recommended that such capabilities be acquired together with appropriate software graphics packages to drive them.

The Institute produces large quantities of environmental data describing many facets of the life and health of the Chesapeake Bay. While most of this data is computer-resident, the retrieval on demand of subsets of data is not a easy task. It is recommended that an effort be made to develop a coherent database management system to make the Institute's data available easily both to in-house and outside users.

3. School of Law

Law School computer use may best be divided into administration/faculty use, Law Library use, and student use, although the categories overlap.

The faculty and administration are supported by an NBI word processing system with six terminals, including one in the Bill of Rights Institute, one in the Law Library, and one in the Law Review offices, and three letter quality printers. The Admissions Office has a terminal tied to the mainframe for database use. The Placement Office has no independent computer capacity but uses the Development Office computer system. The Associate Dean for Administration uses a privately owned Compaq personal computer with a 10 MB hard disk.

The Law Library uses a modified IBM PC and has a LEXIS law retrieval terminal (with printer) that is used by both the faculty and student body.

The student body is supported by four mainframe terminals (with one printer) and six personal computers with three letter quality printers. The student micros are used in computer assisted instruction (mandatory in two courses), word processing instruction, and student word processing. More planning and coordination within the Law School and with the rest of the university is needed.

4. Priorities

The College should be prepared to upgrade its systems as necessary to meet computer demands. Unfortunately, the College does not at present appear to have a high priority for computer facilities. The following description of

priorities at selected Virginia schools was taken from a discussion outline prepared by the Computer Center staff in the fall of 1983.

V.C.U.:   Priority 1 through FY 1984-86, "protected"
U. Va.:   Priority 2, after faculty salaries, "protected"
O.D.U.:   Priority 2, after faculty salaries, "protected"
G.M.U.:   "High Priority", "protected
J.M.U.:   "High Priority", "protected"
C.N.C.:   "Priority", "protected"
Va. Tech: "Effectively protected"
W & M :   "Nurtured", but not "protected"

The lack of priority for computer facilities at the College is also reflected in funding (data from same document as above). Projected computing dollars per FTE student for fiscal 1984-86 for selected Virginia schools is as follows.

U. Va. : $1,239
V.C.U. :   948
V.M.I. :   896
Va. Tech.:   858
G.M.U. :   572
W & M :   564 (650 with academic support fees)
O.D.U. :   473 (618 with supplement)

According to the *Chronicle of Higher Education* (May 30, 1984), a study done for the National Science Foundation estimated that a large university should expect to spend between 100 and 200 million dollars over the next ten years to keep abreast of computing and related communication technologies, and a small liberal arts college between 20 and 30 million. William and Mary falls somewhere between a small college and a large university. However, if the figures above are correct, the computing dollars listed above and projected over ten years add up to less than 20 million dollars. Therefore, the College will need to allocate a sizeable amount of money to keep up with advancing technology.

B.   SURVEY OF STUDENTS

At the present time, students are by far the largest single group of computer users, and they are spending increasingly larger amounts of time using computers. For this reason, certain results of the student survey will be presented in some detail.

In a nutshell, students want more computer resources: more computer power, more terminals, more printers, and more information about the computers themselves and how they can be used. The general sentiment, also shared by many faculty and administrativeusers, is that the available computer power is not growing fast enough.

Table 4 summarizes the current student demand. This demand is concentrated in word processing and class assignments. Table 5 reflects the responses to the question "How should the *average* William and Mary student interact with the computer now and in the future?" It is clear from this data that both current users and non-users feel that computers should become a natural part of campus life in the near future.

TABLE 4

CURRENT USAGE

PERCENTAGE OF STUDENT COMPUTER-USER RESPONDENTS WHO SPEND 25 OR MORE PERCENT OF THEIR COMPUTER TIME IN VARIOUS ACTIVITIES

Computer Activity	% of respondents
word processing	40
CS class programming	33
communication	16
game-playing	14
non-CS class programming	10
statistics	6
other	7

TABLE 5
RECOMMENDED USAGE

PERCENTAGE OF RESPONDENTS WHO FEEL THAT WILLIAM AND MARY STUDENTS SHOULD ENGAGE IN VARIOUS ACTIVITIES

Computer Activity	Now	Within 5 years	Within 10 years
typing papers	76.0	86.8	87.5
programming for self	46.2	76.9	83.5
programming for class	46.9	74.7	81.6
receiving campus news	39.2	65.6	73.9
turning in assignments	21.2	56.3	73.7
receiving assignments	22.6	57.7	73.3
communication	37.8	59.2	70.4
playing games	44.4	54.1	56.9