# Report of the External Review Committee of the Department of Computer Science at the University of Maryland

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May 1986

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## 1. INTRODUCTION

During the last few years, the Department of Computer Science at the University of Maryland has experienced very impressive growth in regular faculty positions, funding for research, and equipment. This extremely rapid expansion has been on the whole managed very successfully. The Department has strengthened its research and teaching programs in several areas, dramatically increased its potential for experimental research in computer science, and hired a large number of high-quality young faculty members. At the same time, the Department has been able to achieve a much needed reduction in the number of its undergraduate majors, and, with further reductions and an expanding faculty, seems to be heading towards an educational load comparable to the average that now characterizes its peer institutions. The recent establishment of UMIACS offers very promising opportunities for strengthening the research program even further with important interdisciplinary components.

This tumultuous growth has not occurred without taking its toll. The most crucial problem it has created is the tremendous shortage of space the Department is suffering from. A shortage of space is a common disease among computer science departments all over the world. In a large number of universities in this country, space is the number one problem in computer science. What makes Maryland's situation particularly worrisome is that the Department is allocated only half of the space that the average institution of similar caliber (which is typically very short of space with respect to its needs) has at the present time in the United States. A survey of computer science facilities recently completed, but not yet published, by the Computer Science Division of the University of California at Berkeley shows that the average department of computer science among the thirty respondents (which included 22 of the top 30 departments in the country) has about 1,000 assignable square feet per regular faculty member. At Maryland, the amount of space per faculty member is approximately 500 ASF.

For the Department of Computer Science, space is not only extremely short: perhaps even worse, it is fragmented. The two sites where departmental space is located are quite distant from each other, and the fact that the Center for Automation Research (where a number of CS faculty and graduate students have their offices) has recently been moved to a third site far from both of the others makes the problem even worse. Keeping all of Computer Science in a single location should be regarded as an extremely important requirement for the Department's welfare. This is particularly true because Computer Science is still a young and relatively fragile discipline, with still rapidly evolving interconnections among subdisciplines. Thus, geographical distance effectively prevents interactions that are absolutely vital to the development of the discipline. Every effort should be made by the University Administration to provide the Department as soon as possible with enough contiguous space for its activities as well as for those of CfAR and UMIACS, which must be kept very tightly coupled with the departmental ones.

Some of the current CS space, especially that in the North Gymnasium, has very poor quality; noise and insufficient ventilation make the working environment quite unpleasant

there. The University should do now whatever it can to improve the environment, and consider very carefully the power, ventilation, and cooling requirements of computer science research in any building that is built or renovated to house the CS Department and the computer-science-oriented research institutes.

Another general problem in computer science departments is faculty overwork, and the CS Department at the University of Maryland is no exception. The normal teaching load of two courses per semester is excessive, even though buying out of courses using research money is a widespread practice which seems to be encouraged by the Department. In most comparable institutions, the normal teaching load is either two or three courses per year, and limited buyouts are allowed, though perhaps not encouraged. As suggested in Section 2 below, the Department could reduce the normal teaching load with positive effects on the graduate program and perhaps some small improvements in faculty workload. Some additional help, though possibly small as well, could be provided by increasing secretarial and grant administration support, as proposed in Sections 3 and 4; for this purpose, soft money could be used while waiting for essential State-funded staff positions. Because of the shortage of senior people coupled with rapid changes in a young and rapidly evolving discipline, it is normal for computer science faculty members at top institutions to be overworked, and there is no effective recipe to make life substantially less hectic for them: the multiple pressures from the students, the sponsors of research contracts, and one's peers in academia and in industry; the administrative needs of university governance in an area in which senior faculty with (or even without) administrative talents are not in abundant supply, the requirements of professional societies, and so on, cannot be avoided. It is, however, an important duty of the Department, the College, and the University to do whatever possible to mitigate these pressures, while at the same time keeping the faculty fully informed and getting it involved in all the important decisions by which their teaching and research work may be affected.

In spite of these problems, and of the others described in the remainder of this report, the External Review Committee found the morale of the faculty, the staff, and the students to be high. [This is certainly due to the substantially correct perception that the Department is an exciting place with a highly positive derivative and a very good, steadily improving overall reputation.]

Following the structure of the Internal Review Committee Report, the rest of this document is divided into four sections. Section 2 addresses our findings and recommendations about the instructional program, Section 3 discusses the research component of the Department's activities, Section 4 the administrative aspects, and Section 5 the Department's external relations.

## 2. THE INSTRUCTIONAL PROGRAM

The Department is offering a good quality educational program, at both the graduate and undergraduate levels, but the number and variety of graduate level courses needs considerable expansion. The program appears particularly good if one considers the extremely large undergraduate population.

### 2.1. Area concentrations

Both undergraduate and graduate programs show generally good balance in courses. Particularly commendable is the coverage of software engineering and human/computer interfaces in addition to more standard computer science courses in operating systems, programming languages, numerical mathematics, and theory of computation. However,

hardware and graphics are less well covered, and the Committee feels that the Department should try to improve the situation, especially in an area as fundamental to computer science as that of hardware and architecture. The trend toward increasing the mathematics content of courses is to be commended, but breadth in computer science must be retained.

## 2.2. Undergraduate majors

The Department handled the dramatic increase in the number of majors and attempted majors well, but perhaps at the expense of the graduate program. Efforts should be made further to decrease the number of majors until a sufficient number of advanced graduate seminars and courses can be offered. It will then be time to restore the Honors program, and commit resources to it.

## 2.3. Ph.D. course requirements

A student pursuing an M.S. degree may obtain a better education than a Ph.D. student who takes the minimum number of courses, passes the comprehensive exam early, and then takes no further courses. No advanced courses are required, nor are many offered. There is contention for tuition funds coming out of research grants and for faculty time. The students are suffering in both the breadth and the depth of their graduate education. For example, a software engineering Ph.D. from Maryland may have neither "theory" nor "information processing" backgrounds. The Committee recommends that course requirements be added to the Ph.D. program, and that a series of advanced courses in the various fields be planned and offered regularly. A student's specialized education should not be constrained by contention for support from research grants, but should be encouraged by departmental regulations and university support. If the normal teaching load of regular faculty were reduced, and buyouts were not encouraged as strongly as they now are, the research money that would be saved could probably be used to fund tuition waivers for Ph.D. students, thereby allowing them to register more frequently and enroll in required as well as optional graduate courses.

## 2.4. Comprehensive exams

The comprehensive examination policies have fluctuated for several years. These fluctuations are normal in graduate departments, even though they create additional stress on the students. However, concerns have been expressed to the Committee about the quality and the administration of the examinations, e.g., about the appropriateness of some questions and the preparation of the proctors.

## 2.5. Fairness

There is a tremendous difference between the treatment of Teaching Assistants and that of Research Assistants. The former often suffer from lack of advising, of space, and of access to equipment. Off-site preparation of textual material is often needed for part-time employed students who do not have accounts on departmental research machines. T.A.s have also suffered from the large undergraduate enrollment. There are morale problems in those students who lack the patronage of a Research Advisor. Since the Department now has considerable amounts of donated and purchased equipment, the Committee recommends that all graduate students be given accounts on a well-supported system, including access to networks and good quality printers. To remedy the lack of advising, all graduate students should be reviewed by the Department at least yearly. In general, the Committee feels that the advising of graduate students could and should be taken more seriously.

Another aspect of fairness is the one having to do with the choice of a research advisor by graduate students. The Department should make sure that the uneven distribution of research funding among the faculty members will not prevent the better graduate students from working with younger faculty.

## 2.6. Teaching quality

The Department has many fine teachers and researchers. The students interviewed understood the impact of the undergraduate enrollment and appreciated the potential improvements stemming from the addition of new faculty members. However, there were few testimonials to memorable learning experiences.

## 3. THE RESEARCH PROGRAM

The total amount of funded research (approximately $3.5 M) is quite substantial. This compares favorably with the research funding of many top departments. If one adds, say, 2/3 of the UMIACS funding (as that is roughly the percentage assigned to CS faculty, at present) plus about 70-80% of that of the Center for Automation Research, then the total funding is clearly very substantial (approximately $7.2 M). On a per faculty member basis, the funding is about $87 K (or $180 K if one includes UMIACS and CfAR). These are very good numbers, particularly given that 10 out of the 40 faculty are new and are at the assistant professor level.

Given this amount of research funding, however, the amount of staff support does not seem adequate. Some of the faculty feel the need for planning staff, who could help in alerting faculty who are not directly connected with some of the existing centers or laboratories about current or future opportunities for research support.

## 3.1. New positions

It would be advisable for the Department to focus now on certain research areas in order to strengthen them. For example, a senior appointment in AI would significantly help that area. There is already considerable expertise in databases, logic programming, and such applied areas as computer vision and robotics. An appointment in the area of planning or knowledge representation would be highly desirable as it would nicely complement the existing expertise. In short, the Department needs to find a highly qualified replacement for Chuck Rieger.

In the theory area, a senior appointment would also provide much needed leadership to a group of very good junior faculty. The coverage of sub-areas in theory is somewhat unbalanced, and care should be taken that it does not become more so. The current emphasis is primarily on the theory of computation.[1] In general, greater breadth within theory should be encouraged. While there seems not even to be any course work on formal languages, the Committee feels that there is an even greater need for more emphasis in courses, examinations, and research in analysis of algorithms. Faculty in the theory area could also benefit from interaction with faculty in parallel processing, vision, and robotics

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1. That at the University of Maryland must be one of the few major computer science departments which have a traditional course in mathematical logic (cross listed with Mathematics) taken by a large number of its students. If this is to remain viable, it will be necessary to stabilize the contents of the course and to emphasize topics which will be of interest to faculty and students in such areas as AI and programming languages, as well as theory.

by getting involved in such fields as computational geometry. Unfortunately, the distance of UMIACS and CfAR from the Department does not encourage these interactions.

## 3.2. Software

In the software area it is also necessary to increase breadth. The faculty should be encouraged to acquire existing software packages, learn to evaluate them and use them to improve their research environment, just as one would use a good compiler. The Department should encourage systems building activities. External distribution of software and even of hardware designs should be regarded as equivalent to publication, and evaluated on the basis of outside letters as well as internal reviews. As in all computer science departments, systems building should not be discouraged among assistant professors because of the fear that they might not publish enough papers to earn tenure.

## 3.3. Conference papers vs. journal papers

In all fields of computer science, some of the major conferences play a key role as publication outlets. These conferences are highly regarded in the community. Their rejection rates are higher than those of many top journals. Thus, the papers accepted by these conferences should be considered as roughly equivalent to those of the best journal papers in the same field. It is important to keep this in mind in considering promotions of computer scientists. This special role played by selected conferences is found in all areas of CS, but especially in the systems area. The Department seems to understand this special role of publication in the major conferences in computer science, and should continue to keep it in mind in considering promotion and tenure.

## 3.4. Computer science as an experimental science

Computer science is as much an experimental science as any other among the natural sciences, such as physics or chemistry, or among the engineering disciplines, such as electrical engineering. This means that computer science must have laboratories both for instruction and for research. The CER grant has played a key role in enhancing experimental work in academic computer science. It is extremely important to maintain these laboratories after the CER grant terminates. The commitments (approximately $300K/year) made by the University Administration for these laboratories are substantial, but they are critical and must be honored if the Department is to maintain its infrastructure for experimental research and instruction. Without maintaining this infrastructure, it is doubtful that the Department could maintain its current momentum and continue increasing its overall funding and its national visibility.

## 4. ADMINISTRATION

The Internal Review Committee of the Department asked the External Review Committee to address four specific questions regarding administrative matters. These were: 1. The level of state support. 2. The number of faculty administrators. 3. How well current space is utilized, and what priorities should be set for the use of existing and new space. 4. Whether part or all of the Department should move off campus to relieve existing pressures. In addition, the External Review Committee considered the role of the departmental field committees, the general departmental organization, and suggestions made by staff.

## 4.1. Staff

In the discussion with staff members, the group format of the meeting made it difficult to get a comprehensive overview of the full range of staff opinions. Nevertheless some themes emerged. It was, for example, clear that staff members feel overworked and feel that the level of staffing is inadequate. As discussed in Section 3, the Committee also believes that *overall* staffing levels are inadequate given the extraordinarily high student load and the very high volume of research funding in the Department. However, data on individual overloading of various administrative staff members was very hard to evaluate. Nevertheless there was a clear staff consensus that many staff members work overtime (weekends) without compensating pay, and do so on a regular basis. This should be a source of concern.

Staff morale seemed high, but several items of concern require attention. As mentioned in Section 1, the general inadequacy of space compels staff members to work in poorly cooled or poorly heated space, a problem which is often caused by heat generated by workstations and sometimes by inadequate control of machine cooling. The Committee itself found that lack of appropriate air conditioning made their own work room, which often contained workstations, uncomfortable. Furthermore, it appears that inadequate office cooling has resulted in frequent breakdowns of recently donated Xerox workstations and printers. Extreme noise in the areas under the North Gymnasium, and the difficulty of lab staff moving from building to building to service a large number of different systems were also cited by staff members as problems, and legitimately so. Finally, problems with parking and ticketing were a surprisingly strong source of staff complaints.

The undergraduate advising office seems to have done an incredibly good job in dealing with extraordinarily large numbers of undergraduates, and the staff of that office deserves special citation for outstanding service. The graduate advising office appears to be unnecessarily burdened by "walk-in" prospective students who wish to be advised about requirements for admission to the graduate program and to be given an opportunity to plead for special consideration. The Committee believes that this is a common problem in good departments located in urban settings. One solution that has worked well at the University of Washington is to hold meetings once every month or two for prospective graduate students to explain admissions requirements and procedures and to discuss general prospects of students who might apply for admission to the graduate program. At Washington, prospective students from the Seattle urban area are not permitted to talk with advisors at any other time. This has significantly reduced the preadvising load on the graduate office, and prospective students have generally been pleased with the procedure. Given the large number of urban professionals and nonprofessionals who are interested in graduate programs in computer science, a more personal and informal approach to advising prospective students does not seem possible without a significant commitment to advising students who are largely ineligible for admission.

## 4.2. Departmental administration

Generally, the External Review Committee was impressed by the departmental organization, and by the use of Associate Chairs to distribute the administrative load among faculty administrators. As far as we could see, this system seems to be working well and seems to be based on an appropriate number of departmental officers. The system seems to us to reflect a generally hierarchical approach to departmental administration and operations. Our general sense is that the departmental style is for "top-down" administration, rather than for a perhaps more democratic and decentralized organization. A few individuals expressed some preference for a system, or style, which would bring more faculty into more substantive administrative roles. Although we found little, if any real dissatisfaction with the current style, the Department might want to discuss this issue.

The Committee does want to express concern about the role of the faculty groups within the Department. While some of these groupings, e.g., theory and numerical analysis, may reflect reasonable clusters, the Committee feels that other groupings may reflect archaic partitions of faculty research and educational interests. In some cases these groupings seem to prevent faculty from teaching in areas quite close to their own research interests. In general, the Committee feels that many of the current groups seem, from an external standpoint, unreasonable even for organizing comprehensive examinations, and that such formal groupings often tend to factionalize a department by setting up too rigid compartments. We have no real evidence that this has occurred at Maryland, but we do believe that the current subdivisions are not particularly natural in terms of research and educational objectives, and that in general such groupings tend to work against the need for students and faculty to look for interactions and interconnections between different research areas. We recommend that the Department reconsider the role of faculty groups in general, and the labels and affiliations of some of them in particular.

## 4.3. University support

The Computer Science Department runs undergraduate and graduate programs which have some of the largest enrollments in the country. Its level of research support easily places it among the top ten departments in the country in terms of total external funding. Given these facts, the current level of university support seems quite inadequate. The adequacy of space has been discussed in Section 1, and will be commented on again below. The number of faculty members is inadequate for the numbers of students served, state-funded secretarial support for faculty members seems almost nonexistent, and apparently only one laboratory staff member is supported from state funds.

When the Department moves into the restructured College of Computing, Mathematical, and Physical Sciences, it will be the dominant academic unit in that College in terms of students served, and it will surely have a significant portion of the total extramural research funding. It should therefore have a number of faculty lines, an amount of faculty and laboratory space, and an allocation of support staff which reflect the size of its research funding and the importance of its educational role within the College.

## 4.4. Space

The External Review Committee was asked to evaluate the Department's use of existing space, and its priorities for use of this space as well as of the space to be acquired for the future.

We were tremendously impressed by what is being accomplished with the existing space, and with how well this space is allocated and used. And we were happy to learn that the University has some plans for alleviating the Department's desperate need for additional space, which is made even more desperate by the the large number of new faculty members the Department and UMIACS are planning to hire.

The existing arrangement, which puts some of the departmental laboratories, including the Center for Automation Research and the UMIACS offices, in separate, often distant, buildings is largely unacceptable. Computer Science is still a young and relatively fragile discipline, with still rapidly evolving interconnections among subdisciplines. Thus, departmental separation and fragmentation is a severe disadvantage in a computer science department, and particularly in one which is expanding as rapidly as that at the University of Maryland. Furthermore, the increasingly experimental nature of the field requires a heavy commitment to laboratories, particularly for major, multi-investigator grants.

We recommend that the Department and *all* of the associated research centers and institutes be housed in contiguous space. This space should be planned in a way which is adequate for an emerging experimental discipline. Adequate laboratory space is essential, as is adequate space and cooling and electrical outlets for offices which will house a variety of workstations and other types of equipment.

## 5. EXTERNAL RELATIONS

The Committee has the impression that external relations present certain problems, and that these problems have been somewhat neglected by the Department, at least until recently. This is not surprising in view of the very severe pressures faced by the Department in areas such as overenrollment, space problems, etc. The Department has also been very busy with attracting and managing a rapidly growing volume of sponsored research funding and the building and staffing of a substantial departmental computing facility and other laboratories, which have been made possible through CER funding from the National Science Foundation. The signs of such growing pains are far from unique to this Department.

### 5.1. UMIACS

The funding of this center represents a real opportunity for the Computer Science Department and the Campus as a whole, but there are also potential problems. Under its acting director, UMIACS appears to have gotten off to a good start. Potentially, the institute could provide much needed stable core funding for research hardware and software support, build an important parallel computing research facility, provide impetus for important cross disciplinary research, and so on. It appears crucial that the offices of the institute remain in close proximity to those of the Department and that the Computer Science faculty play an active role in the search for a Director and in the future advisory structure. There are relatively common misunderstandings in the scientific community as a whole about the nature of computer science research, which is often confused with scientific computing, super computing, and so on. An emphasis on research in core areas of computer science rather than on these other areas seems to be in accordance with the original legislative intent, and the advice of the computer scientists must therefore be heard clearly.

There also appear to be certain other potential problems for the Department. Without close cooperation, UMIACS might build a second group of computer scientists, separated from the Department. It could also factionalize the Department by its ability to decrease the teaching loads and dispense other privileges to a selected subset of the faculty. We emphasize that these are potential, and not existing problems. To date, the impact of UMIACS on the Department has been entirely positive.

### 5.2. The EE Department

The relations between Computer Science and Electrical Engineering appear to be strained, and additional difficulties could result from the presence of the Systems Research Center. Unfortunately an appointment with a representative of the EE Department could not be arranged for the External Review Committee. The difficulties between the two departments appear to stem in part from the overenrollment in the computer science undergraduate program, which has made it difficult or even impossible for CS to admit EE undergraduates to its courses. A rivalry has naturally developed when the engineers have introduced some parallel courses without much coordination with the Computer Science

curriculum. The relations between the two departments appear to have improved recently. The Committee recommends that the departments explore the possibility of joint educational programs such as a computer science-computer engineering Master's degree. The strengths of the two departments should be complementary, and all should be able to benefit from such an effort. As Computer Science and Electrical Engineering move to different colleges, the University might wish to consider establishing a standing committee to monitor relations between the two departments. Such a committee might also monitor relations between Computer Science and expanding "information science" activities within the Library School.

### 5.3. Other departments

The Committee was not made aware of any major problems with the Business School. Conflicts between business schools and computer science departments seems to be rarer these days than in the past, and the situation at the University of Maryland does not differ from the one that seems to prevail now.

The numerical analysts in the Department have a fruitful cooperation with the numerical analysts and applied mathematicians in the Mathematics Department and the Institute for Fluid Dynamics. This tripartite arrangement seems to have worked well for the numerical analysts, and has contributed to Maryland's considerable success in this area. There has been good cooperation between the mathematicians and the recently expanded theory group, and undoubtedly there is potential for even more interaction, but it is much too early to tell to what extent this will happen. We were not made aware of any major conflicts with the traditional science departments.

The question of the new college structure of the Campus, and the affiliation of the Computer Science Department with the College of Computing, Mathematical, and Physical Sciences was briefly discussed. The Committee feels that the creation of a separate College of Computer and Information Sciences should be seriously considered.

### 5.4. The Computing Center

The relations with the Computer Science Center seem to be somewhat uneasy. Not only is the name of this unit a source of confusion,[2] but its choice of hardware and software does not serve the admittedly somewhat special needs of computer science education and research particularly well. A number of software packages important to the computer scientists have not been made available or cannot be made available on the Center's equipment. Editors and other packages available on this equipment are often archaic. Under existing policies the academic departments are expected to pay half of the cost of all but the most standard software. This policy, for which the Center cannot necessarily be blamed, should be changed, or funding should be made available to the Computer Science Department to cover the expenses for its courses. Unless explicitly funded, it is unreasonable to expect the Department to pay the costs of the software required for teaching standard computer science courses.

The lack of graphics equipment should be noted. Many computer science departments are finding that, as the experimental nature of their discipline becomes more apparent, they increasingly need to run a number of specialized instructional laboratories. To date, the Department has only one such laboratory. In the opinion of the Committee, in the near

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2. The University of Maryland must be one of the few, if not the only one, in the country which have a computing center with the term "Computer Science" in its name. We strongly recommend a change of name for the Center.

future the Department will need seriously to consider the option of establishing a number of its own instructional laboratories.

## 5.5. University College

The educational programs in computer science at the University College are believed by some faculty in the Department to be quite poor. Certainly the existence of such programs is likely to be a source of confusion, and their quality could thus reflect poorly on the reputation of the Computer Science Department, which has nothing to do with that activity. We recommend that an appropriate group review the quality of the University College programs.

## 5.6. Industry

The relations with industry through the industrial affiliates program and the Advisory Board seem to be excellent and contribute importantly to the Department in both political support and much needed unrestricted funds.