CUPM, THE HISTORY OF AN IDEA

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I. Fifty Years of Undergraduate Mathematics Teaching.

1. *The idea.* It is appropriate for us in this fifty-year anniversary celebration of the Mathematical Association of America, the national organization of American collegiate mathematics, to review the state of undergraduate mathematical education in the past fifty years, look as best we can towards the future, and consider the work of the Association in it. We shall not be concerned only with the history of a certain standing committee, called CUPM, the Committee on the Undergraduate Program in Mathematics, but more generally with the idea of organizing nationally for the improvement of undergraduate mathematics as it occurs in the classroom and in the college.

2. *Before 1915.* Therefore let us begin by sketching very briefly the significant events and forces in American college mathematics in the fifty-year history of the Association. When the MAA was formed in 1915 there was another movement taking shape which was to have far more influence on college mathematics than MAA would have. This was the extension of compulsory general education in the United States from 8 years to 12 years, that is, to age 18 or through high school. Prior to World War I the American high school had been largely academic and college preparatory. Though public and tuition-free, it had a somewhat restricted enrollment. Mathematics was accepted as a standard subject. The student was expected to complete one and a half Carnegie units of high school algebra and one unit of plane geometry as a minimum college entrance requirement, set by tradition. This same mathematics package was also widely adopted as a high school graduation requirement. The mathematics teacher in the high school usually had completed the equivalent of a minimal undergraduate major in mathematics and many held the master's degree from one of the new American graduate schools formed after about 1890.

These new American graduate schools were beginning to produce an oversupply of graduates with the Ph.D. and their graduates had to take positions in undergraduate teaching for which their graduate education involving research capability went beyond anything they needed or could use in their teaching, and tended to make them discontent with their lot. The leading mathematicians in the American Mathematical Society were bent upon the establishment of a true research community in the universities. Undergraduate mathematics was a burden to them, even if it was a source of financial support as a job outlet for their graduates. However, it was to their credit that these mathematicians, in their drive towards research and graduate work, paused long enough to provide for undergraduate mathematics by helping to establish the Association. Indeed all American mathematicians can justifiably take pride in their continued concern for the teaching of our subject in schools and colleges [23].

3. *Twenty-five year depression* (1915–1940). The extension of compulsory general education through high school age soon overwhelmed the high schools. School educators rejected college preparation as the meaning of high school in favor of a long series of "needs" and "life adjustment," student-centered, philosophies which relegated the difficult subject of mathematics to a low priority indeed. Vocational education proliferated. The level of mathematics required for graduation was greatly reduced and the qualifications of mathematics teachers were ignored. In the colleges this hurt mathematics more than any other subject because it is far more dependent upon years of previous school preparation than the others. High school graduates, going to college in greater numbers over low admission requirements which reflected the colleges' need of their tuition money, soon reduced the subjects of college algebra and analytic geometry to remedial high school, and even grade school, mathematics under various euphemistic designations. The job of the well-trained mathematician teaching in an undergraduate college became still more unattractive. Several commissions of national scope, attempting to remedy the situation, failed [24]. This state of affairs continued until after World War II. Indeed, despite a reversal in the more visible sectors of the educational system, it continues today as the dominant environment in very large sectors which are less favored.

It was my privilege to come into the Association about ten years after its founding and in that stage of life when a brash young man says in effect: "Now that I am finally here, will the world kindly step forward and justify its existence." In my limited world I expected MAA to justify its existence. Was it a professional organization, or union, looking after the economic and social well-being of its members? No. Was it an authority maintaining professional or educational standards? No. Was it devoted to the teaching of mathematics? No, not directly. No, I finally decided that MAA existed to give comfort and status to college mathematicians. It was organized to hold meetings, elect officers, select hour speakers, and publish a journal, just like AMS, only at not so high a level. That was not bad. College mathematicians certainly needed comfort and status. This role of the MAA continues today, but no longer as its only role.

4. *Revival of public support* (1941–1957). After World War II American industry perceived its need for more mathematical education for its employees and, before the impact of either the computer or Sputnik, began to advertise this and offer jobs to mathematicians at all levels. So did government. The National Science Foundation entered the picture, expressing the national policy to cultivate science for the public welfare by an early emphasis on graduate study and research.

In 1953, before Sputnik and before the computer had run wild, E. J. McShane, as President of the Association, sensed the opportunity for educational reform which the new public support would give and appointed a special committee on the undergraduate program, where "program" meant the entire system: the curriculum, the teacher, and the student. This *ad hoc* committee made

a quick survey, reported back to the Board of Governors at the Kingston meeting in September 1953 that there was a "widespread dissatisfaction" with the college mathematics program and recommended a national "program of 'doing' to overcome the inertia of the enormously ponderous structure which carries onward the present program with all of its deficiencies [13]." Then the *ad hoc* committee asked to be discharged. The MAA Board approved the report and directed that the committee be reconstituted as an official committee of the Association to get on with the "doing."

We will return later to narrate the story of CUPM in its effort to "get on with the doing." Here let us note the significance of this action of the President and Board of Governors of MAA. By forming CUPM as a standing committee they involved the Association in undergraduate teaching in a role which it had never played before. This policy change was reinforced later by the formation of the committees on institutes, visiting lecturers, and more significantly the Committee on Educational Media. CUPM was established early enough to set up some patterns for national curriculum work in mathematics, notably the use of summer writing groups [2] to produce source books for new texts, early enough so that it could help to establish the School Mathematics Study Group for elementary and secondary mathematics, and in turn that was early enough so that SMSG could ride the crest of the big computer and space science wave and take advantage of it to make "the new math" a reality in public education. The formation of CUPM was early enough for it to furnish resources for the NSF Summer Institutes program in mathematics. Spreading to the sciences, this idea of organized national curriculum work in science education has become a very big thing in the United States and the leadership of the mathematicians in these matters is generally acknowledged. The idea is spreading abroad, as other nations [17] begin to move in similar ways. It has definitely taken hold. However, we are getting ahead of our story. We return to the general history of U.S. college mathematics.

5. *The space age begins* (1957–1965). The new demand for mathematics and the new Federal support quickly transformed life (and salaries) for university mathematicians. The effect accelerated as the computer field developed and went into orbit with Sputnik. It was pleasant for college teachers to read about the new importance of mathematics too, but overall, matters only became worse again for college mathematics teaching. By cruel irony, now that better students were here, especially the much desired majors in unprecedented numbers, and now that undergraduate mathematics could really challenge a teacher with a full graduate education, such teachers were not available to the great majority of colleges. The new demand had taken them away at the same time that it presented the colleges with five times as many advanced students as before [20]. This is the state of collegiate mathematics as of this date in 1965. With the biggest opportunity and the biggest task it has ever had, the U. S. college teaching staff is probably at the lowest average level of qualification in the 50 years of

MAA. By contrast, in the favored institutions, where most of the members of MAA curriculum committees are, the conditions of undergraduate mathematics are markedly improved, especially the students and the honors programs for the good ones designed by interested and capable faculty members. The disparity between the haves and have-nots in college mathematics has greatly increased in the last 10 years.

6. *The next 50 years* (1965–2015). Let us now try to look into the future, something which is always dangerous to do and even more dangerous not to do.

The easiest prediction to make at the present time is that the graduates of "the new math" in the schools will be so much better prepared, so much more advanced, and so much more sophisticated that we must prepare to teach first year students subjects which we formerly taught in graduate school, only in a more modern way. The only difficulty is in predicting exactly what fraction of the students entering college in the future will qualify for anything from one semester's advanced placement in calculus to the high level just described. Certainly the absolute numbers of students entering with advanced capability will increase, and surely they will gravitate to more favored institutions, as they do now. There they will not need CUPM help.

However, we can infallibly and inexorably predict that the most significant factor in American college mathematics in the next 50 years of MAA history will be the massive expansion of college enrollment, initiated by national, state, and local policy to extend general education from 12 years to 16 years, that is through college, and made as near compulsory as possible. The colleges will be overwhelmed by numbers and mediocrity just as the high schools were in the past 50 years as a result of the expansion of general education from 8 years to 12. This fact will far outweigh the influence of the advanced placement students in the majority of the colleges. Unhappily the college mathematics teaching staff of 1965 may be nowhere near as well equipped for the expansion as the high school staff of 1915 was. I am sure that American college teachers of mathematics will carry out their part of this grand educational undertaking with pride and to the best of their ability. We may also be sure that national organization to improve college teaching in mathematics, the CUPM idea, will be called upon to do everything possible, especially to enable teachers to teach more students, to teach subjects which they do not know, and enable both teachers and students to learn more by themselves.

7. *The objectives of a national curriculum committee.* It is clear enough what a national curriculum commission should do when, as in some European countries, it has authority to establish a curriculum and impose rigid standards. In the absence of any desire for or prospect of such power it was not clear in 1953 what the American CUPM should do, and it still is not clear. Several possible objectives have emerged and undoubtedly more will come out of experience. In 1953 the college program was not as good as the existing staff was

capable of teaching, or the students of taking, so the first objective we saw was to rally mathematicians to do better teaching, to halt the pessimistic retreat to remedial mathematics, to modernize and upgrade the curriculum, and to enlist the aid of the best mathematicians in this. This called for radical and bold forward steps, for a certain amount of showmanship. This objective will always be present. Yet now in 12 years we appear to have reached a stage where the curriculum has advanced faster than the teacher and the objective must be shifted to give aid to the teacher who needs help. It is no longer helpful to recommend that he teach more modern material, if he cannot do it.

I know that I am now departing from the role of a historian to express personal opinions but I should like here to make a plea as forceful and urgent as I can to university mathematicians, who work in CUPM, CEM, and institutes for college teachers. Find out what their job really is, what these college teachers are capable of doing, and give them something which will help them. Don't assume that it is like your job in your university. It isn't. Have the courage to keep the mathematics you offer them simple and appropriate to their tasks. It will not always be mathematics that you are proud of, not as general, modern, radical, original, innovative as you would like to represent your contribution. But if you want to share mathematical culture as you know it in your university with the teachers and their students in large and small colleges, you must start where they are and give them something they can use.

II. The History of CUPM.

8. *The original ad hoc committee.* We have related above how E. J. McShane as President of MAA in January 1953 appointed a Committee on the Undergraduate Program to consider what could be done about the state of undergraduate mathematics in the United States. The committee consisted of G. B. Price (Kansas), A. L. Putnam (Chicago), A. W. Tucker (Princeton), R. C. Yates (U. S. Military Academy), and W. L. Duren (Tulane), Chairman. The first internal memorandum called for policy decisions: To avoid criticism of public policies on education, concentrate on the technically capable students of the first college year, maintain liaison with engineers and physicists ("our best customers"), cultivate new relationships with the social scientists, consider a radical, abrupt change or nothing, be wary of overdoing abstract mathematics, reenlist the interest in college teaching of the best young and old mathematicians, and work to unify departments of mathematics and oppose splintering them. The ever-present problems of supported textbook writing in the public domain were considered in the same first memorandum.

The final report of the group was made to the Board of Governors in September 1953 [2] finding the "widespread dissatisfaction" and recommending: 1) That a "working committee" of five be established to "direct the work, prepare syllabi and commission the preparation of experimental teaching materials to implement a widespread trial of new mathematics courses in colleges;

2) That a subsidy of some $75,000 be sought . . . ; 3) That the working committee be allowed to make decisions . . . upon a basis of their mathematical knowledge and judgement, rather than ones which require ratification by any other body than the Board of Governors of MAA; 4) That the working committee be charged with studying especially the needs of the social sciences, the new needs of engineering and physical sciences, of modern statistics, and biological sciences; 5) That in the interest of liberal education a single theoretical core for a freshman course be sought instead of a battery of specialized courses for special programs; 6) That the new program be established on its own merits by experimentation without authority, accreditation or other form of compulsion; 7) That commercial relationships incidental to the preparation of text materials [be so managed] that the Association will not be in the textbook business."

The report was approved by the Board of Governors which directed that the recommended continuing committee be formed. The continuing committee appointed was the same as the *ad hoc* committee except that C. V. Newsom replaced R. C. Yates to effect a liaison with a joint committee of MAA and NCTM on teacher training.

9. *The work of the old CUP.* The CUP immediately began planning for a summer writing session which was to be held at Lawrence, Kansas, under the direction of G. B. Price, supported by the University of Kansas and a small grant from the Social Science Research Council via the Committee on the Mathematical Training of Social Scientists. The 1954 Kansas Summer Writing Group produced a volume of experimental text materials called "Universal Mathematics, Functions and Limits" [27], and some preliminary writing on a second volume called "Elementary Mathematics of Sets" later completed by an enlarged writing group at Tulane University and the University of Virginia [12].

These materials were tried out in classroom use at Tulane, Kansas, and University of Alabama among other places. These departments wrote critiques of their experience with it [14] [15].

A grant from the Ford Foundation supported the printing and distribution of these materials and later CUP enterprises. Even so, the early work of CUP was done largely on a volunteer basis without fees and with meager stipends for summer writing. This was one of its major mistakes, not to have a big grant.

The first major report of CUP in 1955 described these and other activities of CUP and related curriculum groups [2]. The report called for a single first year analysis course with a division thereafter into a classical calculus course and a new course in mathematical analysis for the social sciences. The latter was a new course for which the text material did not exist. The Dartmouth Writing Group of 1957–58 under the direction of J. G. Kemeny undertook to prepare a source book for this course, under the aegis of CUP. They were published in two volumes under the title, *Modern Mathematical Methods and Models* [19].

Other books encouraged by small helping grants from CUP but mostly

moral support in this period included Artin's *Notes for a Princeton Honors Course in Calculus* [1], Polya's *Mathematical Discovery*, vol. I. [26], and two or three *Carus Monographs*. In addition CUP supported preliminary writing or exploratory studies but not the final published version for several other books.

The idea that CUP would conduct open discussions in the mathematical community of important current issues in collegiate mathematics proved to be a fruitful one, especially in MAA meetings but also in conferences and in institutes [21]. Some typical questions were: The place of logic in undergraduate mathematics courses—now pretty well talked out—statistics [28], early calculus, undergraduate honors work or "undergraduate research." In this same pattern the later CUPM sponsored, without commitment of its own, the New Haven conference on the Doctor of Arts Degree in Mathematics.

Although there were some additions to the original committee including E. J. McShane, J. G. Kemeny, and Brockway McMillan, there had been no provision such as we have now for regular rotation. The committee thought that no small group should remain so long in such a pivotal position in mathematical education. Moreover, the limitations of its scope and available energy were not adequate to the rapidly developing national curriculum work, even after establishing a Central Office at the University of Virginia with R. L. Davis as full-time Executive Secretary. Accordingly the old CUP resolved to liquidate itself to clear the way for reorganization of CUPM with new blood and larger organization.

I might comment here upon the forms of organization of national commissions for improving education in a particular subject. The more common form, because of red tape and organization politics in national professional organizations, is to set up an independent commission under its own board usually housed in a privately endowed university. The difficulty with this is that it tends to become a self-perpetuating clique, not representative, and with a small number of individuals too long in control. The MAA idea has the advantage of a permanent national professional organization having a charter as the unique organization concerned with college education in its field, which can keep its CUPM continuously changing by limited term appointments, and can offer not only prestige but also publishing facilities, the communication facilities of its meetings, and liaison services not otherwise obtainable. Thus under the MAA-CUPM plan the national curriculum committee should in theory have assured prestige, viability, better national representation, better communication facilities for long-term operation than the independent commission can achieve.

The original CUP summarized its own work in two reports [3] [4], with some suggestions for new directions in CUP work. Almost as an afterthought these reports included a sketchy outline of a recommended college curriculum in mathematics. The old CUP had avoided making recommendations as being too prescriptive, but came to believe that its successor CUPM should publish recommendations, and it did, as we shall see.

10. *Reorganization of CUPM.* Before proceeding to reorganize CUPM the Association held the 1958 Washington Conference to review the overall program of the Association and formulate a plan of action [16]. This conference reemphasized the change in character of the MAA to incorporate organized national curriculum work by recommending that the Association recognize five semiautonomous "departments" to carry on its old program of publication and its new programs on the undergraduate program, institutes and visiting lecturers, competitions, manpower and professional guidance.

With CUPM thus endorsed as a distinct arm of the Association, MAA in November 1958 conducted a conference, specifically on CUPM [22] which outlined a structure and a program of work for CUPM, including the preparation of a statement of minimal standards for mathematics teachers "in high schools, junior colleges and colleges," and a statement on preparation for graduate work in mathematics. It emphasized the need of textbooks and urged CUPM to develop a program of subsidized textbook writing. Also it recommended that CUPM delegate specific fields of work to "subcommittees" whose members need not be members of CUPM. These were later called "panels." I might comment that the result of enlarging CUPM itself, forming the panels, and other substructures ultimately brought the number of mathematicians holding appointments in CUPM to about 80, compared with the original 5.

The conference did not neglect to advise CUPM to get a grant from the National Science Foundation.

Early in 1959 incoming President Allendoerfer, upon the recommendation of the outgoing President, G. B. Price, appointed the new committee to consist of G. B. Price, Chairman, E. G. Begle, R. C. Buck, W. T. Guy, R. D. James, J. L. Kelley, J. G. Kemeny, E. E. Moise, J. C. Moore, Frederick Mosteller, H. O. Pollak, Patrick Suppes, Henry Van Engen, R. J. Walker, and A. D. Wallace.

The year 1959 and half of 1960 was devoted to organization and efforts to secure funds, which ended in June 1960 with a grant from the National Science Foundation adequate to support the Committee for full scale work for two years.

11. *CUPM operation under a large grant.* In April 1960 R. C. Buck was appointed chairman of CUPM. It became his responsibility to make good the proposed program of expanded activity. Under his leadership CUPM established a new Central Office at Rochester, Michigan, with Robert J. Wisner as Executive Director. It extended its work by establishing four panels: a Panel on Teacher Training with J. G. Kemeny as Chairman, a Panel on Mathematics for Physical Sciences and Engineering with Robert J. Walker as Chairman, a Panel on Mathematics for Biological, Management and Social Sciences with Patrick Suppes as Chairman, and a Panel on Pregraduate Training of Future Mathematicians with J. C. Moore as Chairman. Each panel had several members

of CUPM on it, other non-member mathematicians, and other scientists from the customer fields who were not professional mathematicians.

From this point this history will not record all of the names of the CUPM family, since they are given in the published annual reports of CUPM [5] and assembled in the appendix to this report.

The newly organized CUPM adopted a basic policy in which it felt that it was diverging from the original group. It involves a critical issue in the idea of organizing nationally for the improvement of mathematical education. As expressed by Buck, it began: "Any approach to college curricula revision must take account of valid differences of opinion about both content and pedagogy; thus there is no attempt to insist upon one specific program." The original CUP, SMSG, and CEM tried to carry out this principle by making no recommendations but, for economy of their own efforts, or for unity in presenting what they had to say, or for reasons of belief that in any one school the basic mathematics courses should be unified as much as possible, they tried to exhibit only one sample of source material for each course. All of them have had difficulty in being understood in this.

The new CUPM chose to carry out this permissive policy of allowable variation in a different way. It made curriculum recommendations but, not only was there diversity by virtue of the independence of the four panels which made them, but, as Buck continued: "In all documents released by CUPM, there have been attempts to indicate alternatives, and indeed to encourage experimentation as an aid to national activity." Accordingly, each of the Panels produced at least one curriculum recommendation for a four-year curriculum for students with special interest in its field and most of these offered alternative structures [6] [7] [8] [9].

Kemeny's Teacher Training Panel, working very hard, came up with its recommendations in a matter of months, then initiated a series of conferences, state by state, to review them with administrators, supervisors, and teachers. Unquestionably these CUPM recommendations have been very influential, especially in the training of elementary teachers, hitherto a difficult group to reach.

The success of this conference plan was due in no small measure to the great energy and imagination of R. J. Wisner as Executive Director. Besides organizing the Central Office, Wisner invented the Consultants Bureau and traveled tirelessly to make the Central Office concept a reality as a means of carrying on the work of CUPM in a magnitude not possible with only the voluntary part-time service of committeemen. Other Executive and Associate Directors of CUPM who have ably carried on the Central Office work while on one or two years leave from their universities are: Bernard Jacobson, A. B. Willcox, B. E. Rhoades, and R. H. McDowell (current Executive Director). For the CUPM idea of organizing nationally for the improvement of mathematical education to succeed, it has turned out that an effective Central Office is an absolute necessity.

When we come to the work of the other panels, in fields where the educational objectives are less specific than in teacher training, it becomes more difficult to evaluate the influence of CUPM recommendations. In reviewing the history of the idea of national curriculum organization in mathematics it would be desirable to do so. The nature of the influence is expected to be different from panel to panel.

The Physical Sciences and Engineering Panel, under the chairmanship of Robert J. Walker, has been remarkable for the patterns of consultation and collaboration that it developed with the Engineers, including at an early stage a conference with some 50 leading engineering educators, continuing through its progressive but realistic curriculum recommendations, its significant recommendations on work in computing [7], its source book of engineering problems [25] produced in collaboration with members of the Commission on Engineering Education, and its continuing work on curricula for space science and mathematical engineering. Its service attitude was expressed by C. W. Jones in his inaugural lecture as Professor of Applied Mathematics at Imperial College [18], comparing CUPM's report with that of a similar European committee: "The difference between these two reports is that whereas the American Committee consists of mathematicians who, having gone to some trouble to find out what is needed, are able to state in detail how it should be provided, the OECD report is the work of engineers and scientists . . . who have a lot to say about the drawbacks of the present state of affairs in Europe . . . ."

By contrast, the Panel on Biological, Management and Social Sciences, chaired first by Suppes, then Kemeny, and now chaired by Samuel Goldberg, is working in an underdeveloped country. Its recommendations are a kind of chart for the future, saying what is needed. The future work saying how that should be provided will of necessity demand a partitioning of this too-large collection of fields and will require the preparation of source materials, particularly in the least developed segment, biomathematics.

The work of the important Panel on Pregraduate Training has not yet appeared to be viewed as a whole. Its first document on *Pregraduate Preparation of Research Mathematicians* [8] was aimed too far into the future to be immediately useful to any but young mathematicians in the formative stages of their teaching. The panel's forthcoming recommendations on *Preparation for Graduate Study in Mathematics* is a more contemporary document describing how the goals of the first report can be approached in an existing department with available texts.

Much of the work of the Advisory Group on Communications, chaired by A. W. Tucker, is on publications policy of internal interest in CUPM but affecting the development of the idea of national curriculum work. However, working originally as an *ad hoc* Library Committee under the chairmanship of Arnold Ross, it produced a recommended Basic Library List [10] for a small college library. This may turn out to be quite timely and important in the forthcoming

era of Federal support of new institutions to meet the college enrollment expansion in the U. S.

The published reports of the panels by no means represent the total effort of CUPM. From the beginning the members of CUPM contributed to the programs of the Mathematical Association and its Sections and to the deliberations of many other scientific bodies and Federal commissions on problems of mathematical and scientific education. Creighton Buck, Baley Price, John Kemeny, Henry Pollak, E. J. McShane, A. W. Tucker and others have been very active in this speaking service, which has turned out to be one of the most important activities to stem from CUPM. In addition CUPM designed a number of seminars, conferences, and film projects which were carried out by other organizations with separate financial support.

In March 1963 it was decided to move the Central Office to Berkeley, California. In June 1963 W. L. Duren, Jr. assumed the chairmanship of CUPM for a three-year term. R. C. Buck remained on the Committee. There was no change in the policy to take account of the diversity of opinions and objectives by offering alternative solutions in CUPM reports.

A major effort was then directed to construct the forthcoming *General Curriculum in Mathematics for Colleges* (CMC) which is an economical synthesis of the panel recommendations for colleges whose programs are too limited to mount such a diversity of courses as the panels all together recommend [11]. This report introduces a new pattern for such statements. Instead of a curriculum, the CMC report offers a system of one-semester course modular units from which a large number of curricula can be constructed in a single department.

In another new pattern, the CMC report is being offered, not as a CUPM recommendation, but as a report to the Association with request for evaluation and criticism by the Sections. If the Sections take hold of this assignment it could be the means of extending within the Sections that transformation and enlargement of purpose which the idea of organization for curriculum improvement has already produced in the national Association.

The field of applied mathematics as an undergraduate concentration on its own, has been explored by an *ad hoc* committee of CUPM, chaired by C. R. DePrima. Its report calls for still new patterns of interdisciplinary and interorganization collaboration, extending into graduate work, at least with the Society for Industrial and Applied Mathematics and the Association for Computing Machinery. Other organizations may also be involved.

12. *The problem of the college teacher.* This history has dwelt in some detail with the use of panels and reports for national organization to get at a variety of difficulties in collegiate mathematical education. The panel method is not universally applicable. In fact, in spite of the many ingenious adaptations so far devised in CUPM, the panel and recommendation procedure may be useless in getting directly into the classroom. When the doors of a classroom are shut, it is relatively insulated from outside influences which would seek to improve

what goes on there. To reach into the classroom a national organization must influence either the subject matter being studied (the course of study, the text), or the teaching medium (the teacher, film, programming of self-teaching), or the student himself. Panel recommendations do not enter the classroom. Panels cannot educate teachers, or produce films, or write textbooks, or prepare students, or select them. The critical factor in the improvement of college mathematics has apparently now become the teacher.

Instead of being overtrained for his job, with a surplus of Ph.Ds., such as we had from 1915 to 1940, the teaching staff in strictly undergraduate teaching is now in 1965 so undereducated and overloaded that CUPM recommendations may come to nothing. The college teacher needs help. CUPM did not perceive this clearly enough to adapt its patterns of activity realistically to the post-Sputnik era or to the less favored undergraduate institutions which have fallen so far behind the universities in richness of mathematical environment.

These institutions can do little to help themselves. The leading universities can no longer produce first rate Ph.D. graduates in sufficient number to help much. So it is an opportunity for great service if a national organization for the improvement of mathematical education can bring relief to the bottleneck in the educational medium, either by helping to produce more qualified teachers, or by helping the less qualified teacher to teach better, or by helping the qualified ones to teach more students.

The problem of producing a qualified college teaching staff in mathematics is to be the main concern of CUPM in the next few years. This is a manpower problem in undergraduate colleges, a graduate school problem in education, and so far everybody's and nobody's problem in the Federal government. At present CUPM regards it as a *quality* problem. For unless the qualified teachers, or some reasonable substitute, can be found the many, many young Americans who go to the colleges whose physical capacity is increased by Federal and State dollars will not get a good college education there. Our concern is for the mathematical component of that education in a society in which mathematical skills are more important than they ever were before.

CUPM has some basic preparatory work to use: the reports of its visiting Consultants, a big survey of college environments completed in 1962 for CUPM by the National Opinion Research Center at Chicago, Henry Pollak's studies of what happens to undergraduate mathematics majors when they graduate, some manpower reports on Ph.D. production in mathematics. But whatever CUPM can contribute will depend on finding radically new patterns for an organized national educational improvement group to attack this problem. That is where we are today.

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26. George Polya, Mathematical Discovery Vol. I, On understanding, learning, and teaching problem solving, Wiley, New York, 1962.

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Appendix. *Membership of CUPM and its Panels after 1959*, (as recorded). See text for membership of earlier committee 1953–58.

I. *The Committee on the Undergraduate Program in Mathematics.*

E. G. BEGLE 1959–63, Ex officio 1964– , R. C. BUCK 1959–65 (Chmn. 1960–63), LEON W. COHEN 1959–61, Ex officio 1964–65, W. T. GUY, JR., 1959–62, RALPH D. JAMES 1959–61, J. L. KELLEY 1959–61, J. G. KEMENY 1959–63, FREDERICK MOSTELLER 1959–62, H. O. POLLAK 1959–65, G. B. PRICE 1959–63 (Chmn. 1959–60), PATRICK SUPPES 1959–62, HENRY VAN ENGEN 1959–61, R. J. WALKER 1959–65, A. D. WALLACE 1959–62, ROBERT J. WISNER, Ex officio 1960–63, ROY DUBISCH 1962–64, DAVID GALE 1962–64, LEON HENKIN 1962–64, E. E. MOISE 1962–64, J. C. MOORE 1962–64, I. M. SINGER 1962–64, R. P. BOAS 1963–66, D. E. CHRISTIE 1963–65, W. L. DUREN, JR. 1962–65 (Chmn. 1963–65), SAMUEL EILENBERG 1963–66, SAMUEL GOLDBERG 1963–65, G. S. YOUNG, JR. 1964–66, R. D. ANDERSON 1965–67 (Chmn. 1965–), C. E. BURGESS 1965–66, M. L. CURTIS 1965–66, C. R. DEPRIMA 1965–67, LEONARD GILLMAN 1965–67, GWENETH HUMPHREYS 1965–66, ROBERT C. JAMES 1965–66, LOWELL J. PAIGE 1965–67, ROBERT M. THRALL 1965–67.

In addition, the Presidents of MAA often actively participated as members of CUPM in their ex officio status in their two-year terms of office. These were in order from 1953: E. J. MCSHANE, W. L. DUREN, JR., G. B. PRICE, C. B. ALLENDOERFER, A. W. TUCKER, R. H. BING, R. L. WILDER 1965–66.

II. *Panel on Mathematics for the Biological, Management, and Social Sciences*, (with dates where recorded).

JOSEPH BERGER 1963–64, ROBERT R. BUSH 1963–66, DOUGLAS CHAPMAN, BERNARD P. COHEN 1964–66, K. K. ESTES, DAVID GALE 1962–65, SAMUEL GOLDBERG 1963–66 (Chmn. 1964–66), R. D. JAMES, LEO KATZ 1964–66, JOHN KEMENY (Chmn. 1963–64), HAROLD W. KUHN 1960–65, H. L. LUCAS 1964–65, FREDERICK MOSTELLER 1959–63, G. BALEY PRICE 1964–65, HOWARD RAIFFA, OTTO SCHMITT 1964–66, MARTIN SHUBIK 1964–66, W. ALLEN SPIVEY 1964–66, THEODOR D. STERLING 1962–65, PATRICK SUPPES (Chmn. 1960–63), GERALD L. THOMPSON 1963–66, ROBERT M. THRALL 1963–65, A. W. TUCKER 1963–65, GEOFFREY WATSON 1960–63.

III. *Panel on Mathematics for the Physical Sciences and Engineering*, (with dates where recorded).

R. CREIGHTON BUCK 1963–65, G. F. CARRIER, BURTON COLVIN 1965–67, E. U. CONDON 1960–64, CHARLES R. DEPRIMA 1962–65, CHARLES A. DESOER, 1959–66, T. P. PALMER, 1960–64, MELBA PHILLIPS 1965–67, HENRY O. POLLAK 1959–65, G. BALEY PRICE 1959–64, MURRAY PROTTER 1960–64, A. H. TAUB 1963–65, R. J. WALKER 1959–65 (Chmn. 1959–65), MILTON WING 1963–65.

IV. *CUPM, Panel on Pregraduate Training*, (with dates where recorded).

R. D. ANDERSON 1962–64, 1965–67, LOUIS AUSLANDER 1965–67, PAUL BATEMAN 1965–67, RALPH P. BOAS (Chmn. 1963–65), D. W. BUSHAW 1965–67, DAN E. CHRISTIE 1963–65, EARL CODDINGTON 1959–64, LEON W. COHEN 1959–66, LESLIE DWIGHT 1964–66, ELDON DYER 1959–64, SAMUEL

EILENBERG 1963–65, LEONARD GILLMAN 1965–67, GEORGE E. HAY 1964–66, LEON HENKIN 1962–65, SAMUEL KARLIN, VICTOR KLEE 1965–67, PETER LAX, HERMAN MEYER 1965–67, KENNETH O. MAY, JOHN MOORE 1959–64 (Chmn. 1959–63), IVAN NIVEN 1962–65, GEORGE SIMMONS, A. D. WALLACE 1959–63, GERALD WASHNITZER, A. B. WILLCOX 1965–67.

V. *Panel on Teacher Training*, (with dates where recorded).

E. G. BEGLE 1959–67, ROY DUBISCH 1962–65, MARY FOLSOM 1963–65, W. T. GUY, JR., CLARENCE HARDGROVE 1963–65, P. S. JONES, JOHN L. KELLEY, JOHN KEMENY (Chmn. 1959–63), BRUCE MESERVE 1962–64, EDWIN E. MOISE 1960–65 (Chmn. 1963–64), HENRY VAN ENGEN, GAIL S. YOUNG, JR., 1963–66 (Chmn. 1964–).

VI. *Advisory Group on Communications.*

JOHN D. BAUM 1963–65, DAN E. CHRISTIE 1963–65, CHARLES R. DEPRIMA 1963–65, MARION K. FORT 1963–64, ROTHWELL STEPHENS 1963–65, ROBERT THRALL 1964–65, A. W. TUCKER 1963–65 (Chmn. 1963–65).

VII. *Executive Officers.*

ROBERT L. DAVIS (Executive Secretary 1956–58), ROBERT J. WISNER (Executive Director 1960–63), BERNARD JACOBSON (Associate Director 1962–63), A. B. WILLCOX (Executive Director 1963–64), B. E. RHOADES (Associate Director 1963–64, Executive Director 1964–65), R. H. MCDOWELL (Associate Director 1964–65, Executive Director 1965–66), W. T. SLABY (Assistant Director 1965–66), L. K. DURST (Associate Director 1966, Executive Director 1966–67).

Central Offices located at: University of Virginia 1956–58, Michigan State, Oakland and Pontiac, Michigan 1960–63, Berkeley, California 1963–

VIII. *Consultants Bureau.* (No specific terms. All have served at some time.)

R. D. ANDERSON, JOHN D. BAUM, HOWARD E. CAMPBELL, ROY DUBISCH, LINCOLN K. DURST, PHILIP DWINGER, JOHN V. FINCH, ROBERT C. FISCHER, MARION K. FORT, DWIGHT B. GOODNER, W. T. GUY, JR., LEON HENKIN, JAMES HUMMEL, BERNARD JACOBSON, PAUL B. JOHNSON, BURTON W. JONES, PAUL J. KELLY, EUGENE E. KOHLBECKER, ARTHUR LIVINGSTON, ROBERT H. MCDOWELL, ANIL NERODE, ROBERT Z. NORMAN, WILLIAM R. ORTON, JR., B. J. PETTIS, MINA S. REES, CHARLES RICKART, GERALD ROGERS, HARTLEY ROGERS, JR., SEYMOUR SCHUSTER, LELAND SCOTT, WILLIAM R. SCOTT, E. BAYLIS SHANKS, JAMES H. STODDARD, JOHN WAGNER, ELBERT WALKER, FRED WRIGHT, JAMES H. ZANT.