Mina Spiegel Rees (1902–1997)

Judy Green, Jeanne LaDuke, Saunders Mac Lane, and Uta C. Merzbach

Judy Green and Jeanne LaDuke

Mina S. Rees died in New York City on 25 October 1997. Although she was probably best known in the mathematical community for her work with the Applied Mathematics Panel of the National Defense Research Committee during World War II and with the Office of Naval Research after the war, her influence on mathematics and science extended far beyond her years with the federal government. She was also known as a scholar and remarkably effective administrator, and she was extensively recognized for her farsighted contributions to the formulation of policies concerning mathematical research, federal support of science, and graduate education.

Mina Spiegel Rees was born 2 August 1902 in Cleveland, Ohio, and grew up in New York City, where she attended Hunter College, then a women's college. After her graduation summa cum laude in 1923, Rees became an assistant teacher at Hunter College High School and a full-time graduate student at Columbia. She recalled later, "When I had taken four of their six-credit graduate courses in mathematics and was beginning to think about a thesis, the word was conveyed to me—no official ever told me this, but I learned—that the Columbia mathematics department was really not interested in having women candidates for Ph.D.'s. This was a very unpleasant shock. Of course, this is certainly not at all true of the mathematics department at Columbia now. I decided to switch to Teacher's College and take the remaining courses necessary for an M.A. there."[1]

Rees received her M.A. in 1925 and was hired as instructor of mathematics at Hunter College in 1926. Having had an interest in associative algebras since her work at Columbia and realizing that she wanted to get a Ph.D. in that area, Rees decided to go to the University of Chicago so that she could study with Leonard Eugene Dickson, a leader in the field whose work she knew. However, when she arrived at Chicago in 1929 with a leave of absence from Hunter College, Dickson's attention had turned to number theory. Even so, he asked Rees to be his student, and she completed her dissertation in associative algebras under his supervision. The dissertation was published in 1932 in the *American Journal of Mathematics* [7].

After receiving her degree in 1931 Rees returned to Hunter College as an instructor. She was assistant professor 1932–40 and associate professor 1940–50, although with the advent of World War II her interests and talents were refocused, and she took an extended leave of absence from Hunter in 1943 to contribute to the war effort. Her publications during these first years at Hunter consist mainly of book reviews published in *Scripta Mathematica*.[2]

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[1] *Interview with Rosamond Dana and Peter J. Hilton in [1], p. 258.*

[2] *An extensive list of her other publications, along with material about her life and work, is found in: Phyllis Fox,* Mina Rees, *Women of Mathematics: A Biobibliographic Sourcebook, edited by Louise S. Grinstein and Paul J. Campbell, Greenwood Press, 1987, Westport, CT, pp. 175–181.*

In 1942 the National Defense Research Committee (NDRC) was established as a part of the Office of Scientific Research and Development. The Applied Mathematics Panel (AMP) was set up as a part of the NDRC the following year, and Warren Weaver, chief of the AMP, asked Rees to become a technical aide and his executive assistant. In that position and as secretary to the panel, Rees was in a central position with respect to the problems that were posed by the various military constituents, efforts to extract the mathematical essence of the problems, and the task of finding mathematicians to solve them. Rees represented the government in contracting the problems to various universities throughout the country. She described the activities of the panel in a 1980 article [11] in the *American Mathematical Monthly*. Shortly after the end of the war, Rees received the President's Certificate of Merit in this country and the King's Medal for Service in the Cause of Freedom awarded by the British government in recognition of wartime civilian services by foreign nationals.

In 1946 Rees went to Washington, DC, as head of the mathematics branch of the Office of Naval Research (ONR). Subsequently she was director of the mathematical sciences division, 1949–52, and then deputy science director, 1952–53. In a 1948 article [8] Rees noted that the ONR was committed "primarily to the support of fundamental research in the sciences, as contrasted with development, or with applications of known scientific results—the types of activity in which scientists were largely engaged during the war." The article goes on to describe activities in pure mathematics and in applied mathematics, including especially mathematical statistics and computer theory and development. The significance of Rees's role at the ONR was recognized in a resolution adopted by the Council of the AMS at its annual meeting in December 1953 and in a similar resolution adopted by the Institute of Mathematical Statistics. The former reads in part:[3]

> Under her guidance, basic research in general, and especially in mathematics, received the most intelligent and wholehearted support. No greater wisdom and foresight could have been displayed and the whole postwar development of mathematical research in the United States owes an immeasurable debt to the pioneering work of the Office of Naval Research and to the alert, vigorous and farsighted policy conducted by Miss Rees.

[3]*Bull. Amer. Math. Soc.* ***60*** *(1954), 134.*

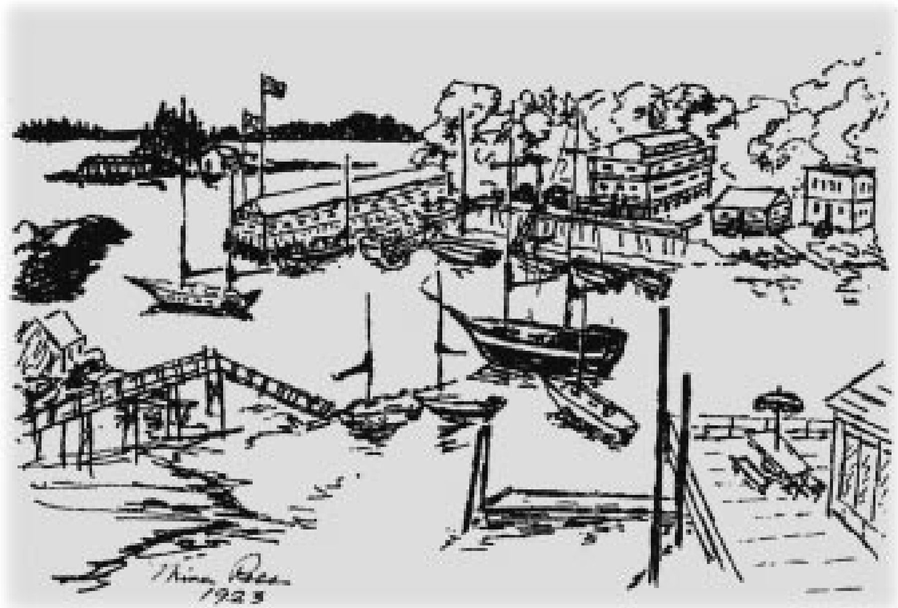
Photograph courtesy of Bachrach and the Mina Rees Library, CUNY Graduate School, NY.

Mina Rees

In the 1950s Rees wrote a number of articles that convey a sense of the wide range of her interests at that time. Among these is a remarkably comprehensive one [9] on the federal computer program that appeared in *Science* in 1950, having first been delivered as an invited address to the then recently founded Association for Computing Machinery. In 1952 she published a research article [2] with Richard Courant and Eugene Isaacson in *Communications on Pure and Applied Mathematics.* She wrote several other articles, especially on computers and computing and on expanding roles for mathematicians.[4] Thirty years later Rees contributed more to the history of that period. An important survey [12] of the computing program at the ONR first appeared in 1982. Rees was also a member of the MAA committee on World War II history and contributed financial support for the preparation of a history of the Institute for Numerical Analysis at UCLA that had been commissioned by the National Bureau of Standards and the ONR.

Rees returned to Hunter College as professor of mathematics and dean of the faculty in 1953 and remained in those positions until 1961. In 1955 she married Leopold Brahdy, a physician who died in November 1977. During her tenure as an admin-

[4]*See, for example,* Digital computers—their nature and use, *American Scientist* ***40*** *(1952), 328–335, and* Mathematicians in the market place, *Amer. Math. Monthly* ***65*** *(1958), 332–343.*



Pleasure Boats at Anchor,
Booth Bay, Harbor, Maine. 1923

Sketches of scenes from Maine by Mina Rees, courtesy of Saunders Mac Lane.

istrator at the college, Rees was appointed to numerous boards and committees by the National Research Council, the National Bureau of Standards, and the National Science Foundation, among others. For example, she served as consultant to the Bureau of the Census to prepare for machine handling of the 1960 census data. Details about many of these positions can be found in the citation accompanying the MAA's first Award for Distinguished Service to Mathematics, which she received in January 1962.[5] Two years later the United States Senate confirmed her appointment to a six-year term on the National Science Board.

In 1961, when the City University of New York was established, Rees was appointed professor and dean of graduate studies. At that time the university consisted of three community colleges and four senior colleges: City, Hunter, Brooklyn, and Queens. Rees was instrumental in developing and shaping graduate studies at CUNY. She was provost of the graduate division 1968–69 and was appointed as the first president of the Graduate School in 1969. In 1970 a colleague described Rees in [13] as "a person of engaging warmth and liveliness, of boundless energy, and—foremost—of an extraordinary directness and clarity in interpretation, giving sight to imagination." She retired as president emeritus in 1972.

As the 1965 American Association of University Women Achievement Award Winner, Rees was described as the only woman dean of a graduate school in a coeducational institution. Rees [10] noted at the time:

> It may be because the Graduate Dean is a woman, or it may be for completely objective reasons, that ours is proving an ideal university to draw into advanced graduate work the most obvious source of unused talent in a society that desperately needs additional numbers of persons with training through the doctorate, namely, women.

Among attractions to women offered by the Graduate School, she added, "we have welcomed qualified women who have applied even to the extent of considering the need for a babysitter a proper reason for providing financial assistance." In a similar vein, Rees was a supporter of the Association for Women in Mathematics. Her 1990 letter accompanying a generous contribution to AWM's Schafer Prize Fund[6] reads in part, "I was …thrilled at the clear indications that we shall be producing truly distinguished women mathematicians in the immediate future who will carry on the trend that is well on its way."

Mina Rees held policymaking positions in a number of professional societies: she served as a trustee of the AMS, on the board of directors of the Society for Industrial and Applied Mathematics, and as chair of the Council of Graduate Schools in the U.S., among others. In 1970, shortly before her retirement and after many years of service within the association, Rees became president-elect of the American Association for the Advancement of Science (AAAS). The following year she served as president, the first woman in this position since the founding of AAAS in 1848. Furthermore, she is the last of the eight mathematicians who have held this position to date.[7]

In 1983 Rees was awarded the Public Welfare Medal by the Council of the National Academy of Sciences. The citation accompanying the award,

[5]Award for Distinguished Service to Mathematics, *Amer. Math. Monthly* ***69*** *(1962), 185–187.*

[6]*The Schafer Prize is awarded annually to an undergraduate woman in recognition of excellence in mathematics.*

[7]*Presidents of AAAS who can be considered mathematicians are Benjamin Peirce (1852 and 1853), Simon Newcomb (1877), H. A. Newton (1885), R. S. Woodward (1900), E. H. Moore (1921), G. D. Birkhoff (1937), Warren Weaver (1954), and Mina Rees (1971). We thank Mary Beth Ruskai for pointing out the paucity of mathematicians among presidents of AAAS.*

described by NAS as "one of the most prestigious of the National Academy honors,"[8] reads:

> for her contributions to the scientific enterprise, especially in mathematics, astronomy and computer science, from wartime through the transition from war to peace and continuing today.

Rees later commented that the award was "intended to focus on the benefit to the country of the development of science and its application." She also explained that "it gives you all the privileges of the academy except electing members."[9]

Among many honors not yet noted are at least eighteen honorary degrees from U.S. colleges and universities. Finally, as a lasting tribute to her academic and professional excellence, the library at the Graduate School and University Center of CUNY was dedicated in 1985 as the Mina Rees Library.

Saunders Mac Lane

About 1928 Mina Rees enrolled as a graduate student of mathematics at the University of Chicago. She later told me that previously, in her studies in New York, she had learned of the research of Professor Dickson at Chicago on associative algebras, and she hoped to prepare a thesis in this field. When she arrived at Chicago, she found that he was no longer active in this field, but had turned his attention to Waring's problem and his students were now working on that. Nevertheless, she succeeded in getting him to direct her thesis in algebra. This thesis is now in the Eckhart Library in Chicago.

I graduated from Yale in 1930. President Hutchins had arranged for me to have a good fellowship at Chicago. I was an aggressive student there; I met Mina and many others. Someone even suggested that she should consult me about her review for the Ph.D. exam; this of course did not happen. She and I at one point played tennis on one of the university courts. She passed her exams with no trouble. Julia Bower, a fellow graduate student of Mina's at Chicago, said the following of her.[10]

> You and I knew Mina Rees during our first year at Chicago.…Vibrant would be a word to describe her. She was happily and totally interested in the people around her and in all the events taking place. I sat next to her in one of Professor Lane's classes. While most of us were busily taking notes, she sat there concentrating every fiber of her mind on what was being said, only occasionally writing something or making an intelligent remark or asking an intelligent question. I had the feeling that she was so thoroughly absorbing the important points that she would not need to do any further studying at all.
>
> I believe that all of her life she went directly to the heart of a problem and dealt with it efficiently. Yet she had patience with those who were not so bright. She really liked people and enjoyed being with them.

At that time, the University had many—maybe fifty or more—graduate students in mathematics, chiefly hoping to get a Ph.D., for which a research thesis was required. However, the chairman, Gilbert A. Bliss, was realistic. He guessed that many of them would not continue in research; in fact, he at one point said that the thesis research was there to have the students learn what research was like so as to give background for their subsequent teaching. So some, but by no means all, went on to do research—for example, Adrian Albert, a student of Dickson in algebra, obtained his Ph.D. in 1928; E. J. McShane in 1930; and Magnus Hestenes, about 1933.

At that time the three leading mathematics departments were Harvard, Princeton, and Chicago. A number of other universities had groups of mathematicians active in research; examples include Yale, Michigan, and Wisconsin.

Jobs for the new Ph.D.s were arranged by the old boys' network. Bliss knew all the department chairmen and chose which students to recommend where. There were a considerable number of women among them (none at Princeton, few at Harvard). Often the Chicago women Ph.D.s were sent to teach at women's colleges; at that time, only Bryn Mawr among the women's colleges was active in research in mathematics. Mina went back to Hunter College in 1931.

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[8] Rees Awarded Medal, *AWM Newsletter* ***13***, *no. 3 (May-June 1983), 9.*

[9] *Interview with Rosamond Dana and Peter J. Hilton in [1], p. 263.*

[10] *Excerpt from a letter to Saunders Mac Lane in April 1998 from Julia W. Bower.*

Saunders Mac Lane is Max Mason Distinguished Service Professor, Emeritus, at the University of Chicago. This segment is adapted from a statement made at a memorial service December 8, 1997, at the Graduate School and University Center, CUNY.

Bathing Beach on the Marginal Way Ogunquit, Maine. 1982

Mina's 1931 Ph.D. thesis was published in the *American Journal of Mathematics* as "Division algebras associated with an equation whose group has four generators" [7]. It dealt with the construction of certain associative algebras by highly computational methods. Those methods had been developed at Chicago by Dickson, who had written a book about them, *Algebras and Their Arithmetics* [3].

Mina's return to Hunter in 1931 represents a missed opportunity for mathematics. In fact, Mina Rees's graduate study came at exactly the time when there was an ongoing great revolution in algebra: "modern algebra" was developed in Göttingen by Emmy Noether and was supported by Emil Artin, Helmut Hasse, and B. L. van der Waerden. Van der Waerden's splendidly influential book *Modern Algebra* did not appear until 1930–31 and did not at once attract attention in this country. I had the good luck to learn of Noether's work in 1929 at Yale from Professor Oystein Ore and from a Noether-influenced (but pedantic) text by Otto Haupt.

When I arrived for graduate study at Chicago in the fall of 1930, I was surprised to find there little or no knowledge of Noether's work. I did not understand that it could be applied to the Chicago specialty of linear associative algebras. Consequently I did not discuss it with Mina, even in connection with her thesis. I learned that Adrian Albert had recently written a Chicago thesis on linear algebras and had won a National Research Council Fellowship for postdoctoral study (at Princeton).

For my part, I wrote an M.A. thesis reflecting some ideas in abstract algebra, and in June shook the dust of Chicago from my feet to go study in Göttingen; I somehow knew that there was real logic and algebra there.

On my arrival, Professor Hermann Weyl told me that Fraulein Noether was the leading algebraist—his equal. So I listened to Noether's (sometimes confusing) lectures on hypercomplex systems. I was startled to find that she often cited an influential German translation *Algebren und Ihre Zahlentheorie* of Dickson's book—though I had not heard Dickson talk about his book in his course in number theory. I heard from Noether about the use of factor sets, but did not then understand them. Much later I did. They made Mina's thesis obsolete. The idea used by German group theorists in the 1920s is simple: Try to describe a group G in terms of a given normal subgroup N and the corresponding factor group Γ. The group consists of cosets Nu_σ, one for each σ in Γ. The group law for G follows from knowing how to multiply u_σ and u_τ. Write $u_\sigma u_\tau = f(\sigma, \tau)u_{\sigma\tau}$ with $f(\sigma, \tau)$ in N. Then write the associative law as an equation in f's. This f is a *factor set*. Factor sets provide a startling simplification of the cumbersome verification of the associative law for linear algebras as then done in the Chicago school. They work for algebras: For example, to get the quaternions, start with the complex numbers $\mathbb{C}$ and their Galois group over the reals, which is cyclic of order 2 with generator j. The action of j on $\mathbb{C}$ is given by $jc = \bar{c}j$, and the formula for the factor set comes down to $jj = -1$. Dickson's cyclic algebras had carried out this construction for arbitrary cyclic groups. Noether's lectures in Göttingen in 1929–30 first used factor sets for arbitrary finite groups to define associative algebras as crossed products. I personally did not understand factor sets well at the time of Noether's lectures, but later Eilenberg and I used factor sets to invent the cohomology of groups, as is explained in [4]. They still involve heavy computation.

The late Adrian Albert once told me that his own study of Dickson's construction of cyclic algebras led him to invent factor sets on his own. He showed them to Professor Dickson, who dismissed them as too much formality. Dickson had shifted his interests back from algebra to number theory (as I know from his 1930–31 course). His real motto was "One subject at a time".

Now for a missed opportunity for mathematics in connection with Mina. Mina's thesis was finished in the spring of 1931. Professor Dickson might then have recommended her for an NRC postdoctoral fellowship. If she had won one, and if she had heard of Noether, she could have gone to Göttingen, where she would surely have attended Noether's lectures on hypercomplex systems and factor sets. From Mina's subsequent accomplishments we know that she would have understood these notions and made use of them to simplify her earlier proof. We know that Emmy Noether took care of her associates and students, both men and women. We also know about Mina and so can imagine many splendid research results. But it was not to be.

Yes, I understand. A fellowship for a woman was not the way the mathematical world usually worked then. At that time I would not have dared to talk back to Professor Dickson, a towering figure in American mathematics.

The work of the Germans essentially made Mina's thesis obsolete. It would then have been very hard for her to do further effective research—quite aside from the situation that women mathematicians at that time were not expected to do research. Indeed, she did not publish any further research in the next decade.

War research from 1941 in physics and such subjects was active in Chicago, but there was little use of mathematicians, to the disgust of leaders such as Marston Morse and Marshall Stone. Warren Weaver, an applied mathematician from Wisconsin, then an assistant director at the Rockefeller Foundation, was active in the NRDC and the OSRD. Early in 1943, in a shift, an "applied mathematics panel" was established. This panel established "applied mathematics groups" at Columbia, Princeton, and later NYU and Northwestern. These groups had government contracts and hired mathematicians and other scientists to do war research on problems proposed by the Government Applied Math Panel. To oversee this work, Weaver had several so-called "Technical Aides". I believe they were government appointees. Mina Rees was one of these. Richard Courant had recommended her to Weaver.

The Rocks at Ocean Point, Maine. 1983

From April 1943 to September 1945, with one gap, I was a member of the "Applied Math Group, Columbia (AMG-C)" and was its director for the last year. In this connection I knew of Mina's work for AMP. I do not recall any detailed connection of her work with AMG-C; we had a different Technical Aide, to whom I paid little attention. I negotiated directly with Weaver and often disagreed with him. Mina admired him. Many years later she wrote a biographical memoir on Weaver for the National Academy of Sciences.

The planned National Science Foundation was not set up directly at the end of the war, but the government support of scientific research was considered important and was then carried out by the defense agencies, especially by the Office of Naval Research (ONR). Alan Waterman (later the first director of the NSF) headed the ONR, and Mina was the program director for mathematics there. The work was successful. Mina once told me that it was then easy to get "peer review" for the projects proposed; she knew all the leading mathematicians and called them up for advice about projects.

After this stint Mina returned to Hunter College. I saw her from time to time, though I never met her husband. For many years she and I exchanged Christmas cards; in particular one such included her sketches of scenes from Maine.

In 1983 Mina was awarded the Public Welfare Medal of the National Academy of Sciences. This is a medal awarded once a year to a person who has made important contributions to science, but not of the nature of research. The other mathematician to have received the medal was Warren Weaver, who received it in 1957.

Mina was a member of the National Science Board from 1964 to 1970. R. H. Bing, a mathematician from Wisconsin and Texas, was also a member for an overlapping period. He told me that the interaction of two mathematicians helped greatly. Since then there have never again been two mathematicians on the National Science Board at the same time.

Uta C. Merzbach

When the National Academy of Sciences chose to honor Mina Rees with its Public Welfare Medal, she received an award described by the original proponent[11] as "a medal for eminence in the application of science to the public welfare." When the mathematical community chooses to honor Mina Rees's contributions, it is for eminence in the application of public policy to the welfare of mathematics.

Certain personal characteristics enabled Mina Rees to promote basic research so effectively and to establish a solid foundation for sustained public support of mathematics.

Mina Rees was eminently rational. Her devotion to reason helped her formulate goals clearly and allocate resources judiciously in accordance with these goals. This applied to decisions concerning her career as much as it did to dispensation of public funds. In neither area did it always meet with approval or understanding. She could be a tough contract administrator. There were engineers who never forgave the woman whom they regarded as the epitome of the autocratic Washington administrator with little understanding for cost overruns. At the same time there were mathematicians who never forgot to praise this colleague, whom they saw as their support for unfashionable causes such as the revitalization of research in numerical analysis.

Mina Rees was eminently intelligent. She comprehended quickly, communicated effectively, and thought creatively. Her ability to attach realizable pieces of basic research to mission-oriented applications of mathematics did much to develop a broadened base of support for mathematicians' work.

Mina Rees was eminently civilized. Her diplomatic skills were considerable; her conversational technique bespoke her broad knowledge base as well as her wide interest in mathematical and nonmathematical topics. Experience and reflection led her to a balanced outlook on teaching and research, the arts and the sciences, long-range and short-range planning, and the obligations of the professional and the private life.

In recalling meetings and conversations with Mina Rees, another, less well-known, characteristic comes to mind. It pertains to her interest in the history of her time. My acquaintance with her dates back to the 1960s. She had taken charge of the graduate program at CUNY; I was interested in learning more about her activities at the Applied Mathematics Panel and with ONR. We had stimulating conversations, but when I requested that she provide the Smithsonian's Computer History Project with some formal taped interviews, she initially demurred, explaining that that part of her life was over and that she could probably provide little information. Although she did agree to the interviews, I was puzzled by her reluctance. Neither her memory nor her self-assurance seemed to be impaired. Was it a disregard for history, a feeling that she had more important things to do? More than a decade and more conversations passed before I realized that just the opposite was true. She had a keen sense for the difference between anecdotal and documented statements. She shared the concern of her contemporaries Bailey Price, Barkley Rosser, and others that the contributions of American mathematicians in the critical years of World War II and the immediate postwar era be properly documented and revealed. Her autobiographical publications of the 1980s were largely the result of the realization that neither she nor her contemporaries would live to see the day when a qualified scholar had written the history of that period. In making her own contribution toward that day, she was meticulous in checking her sources, cross-checking her memory and that of her colleagues, and ensuring that she followed proper stylistic protocol. I know no graduate student more concerned than Mina Rees when she telephoned to ensure that she had used a proper citation style for a bibliographic reference.

Above all, Mina Rees was a mathematician who loved mathematics and believed in supporting those who are capable of contributing to its growth and propagation. She persuaded relevant members of the mathematical and governmental power structures that mathematicians can provide important public service and that such service to the public sector is most fruitfully balanced between theory and applications. With this singular accomplishment she provided the framework after World War II that enabled mathematicians to ben-

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[11] *George F. Becker in 1909, quoted in the interview with Rosamond Dana and Peter J. Hilton in [1], p. 262.*

efit from public support and to multiply their institutional foci.

We are memorializing Mina Rees at a time when the interest of young Americans in mathematical research is at a low point. In 1948 she wrote an article [8] in the *Bulletin* intended to acquaint the American mathematical community with the work of her division at the Office of Naval Research. The piece is of interest for the clear formulation of goals, the diplomatic approach in enlisting support, and the understanding of the narrow base of mathematical research in the United States at the end of World War II. A half century later her motivational call is still pertinent:

> It is hoped that the impact of this program on the mathematical life of the United States will be in the direction of stimulating significant mathematical research, and of enabling the faculties of universities in all parts of the country to encourage the interest in mathematical research of their most promising students. It is expected that this activity will contribute toward the production of a gradually increasing corps of able and experienced mathematical research workers.
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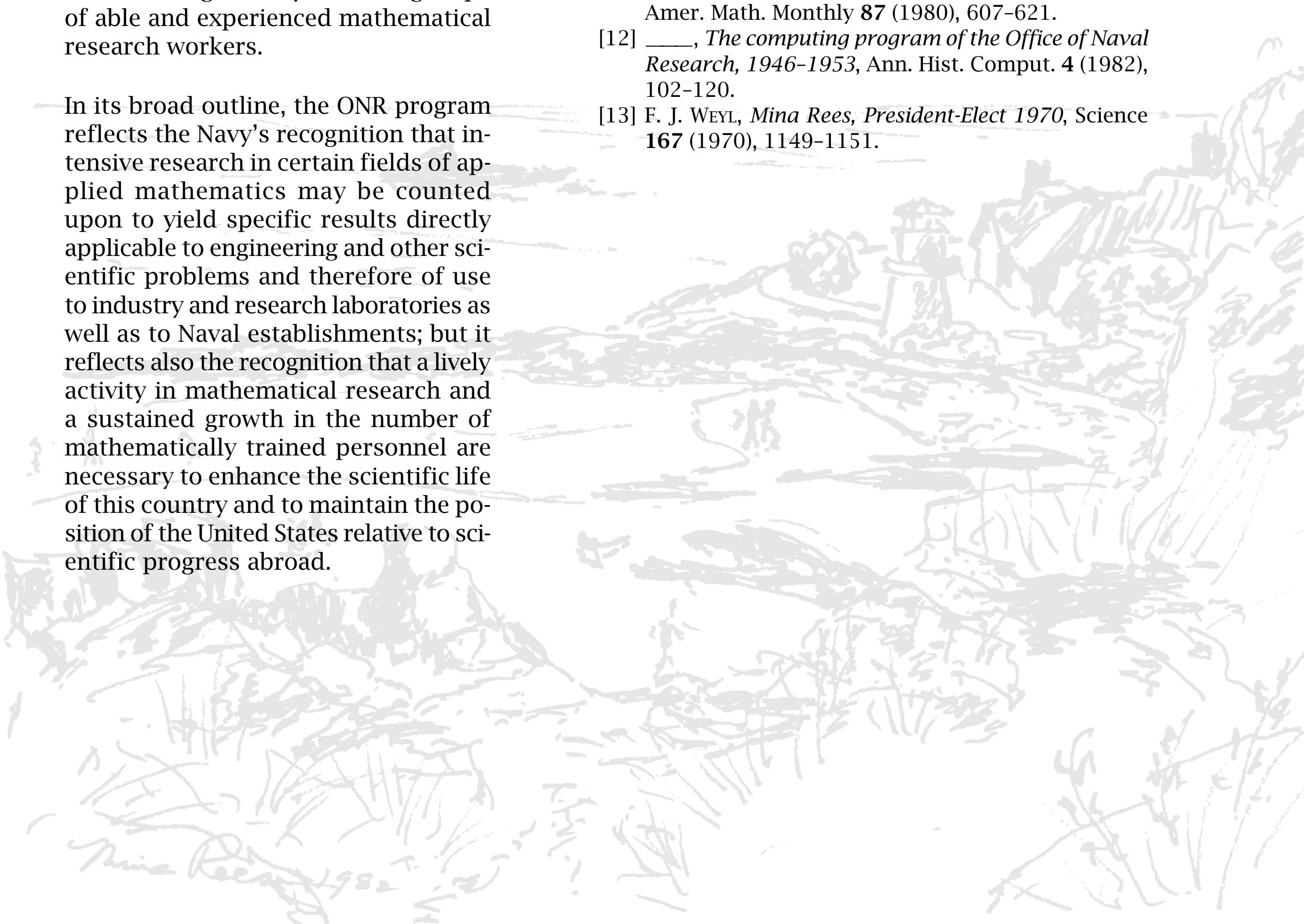
> In its broad outline, the ONR program reflects the Navy's recognition that intensive research in certain fields of applied mathematics may be counted upon to yield specific results directly applicable to engineering and other scientific problems and therefore of use to industry and research laboratories as well as to Naval establishments; but it reflects also the recognition that a lively activity in mathematical research and a sustained growth in the number of mathematically trained personnel are necessary to enhance the scientific life of this country and to maintain the position of the United States relative to scientific progress abroad.



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