Ronald N. Bracewell

L.M. Terman Professor of Electrical Engineering Emeritus

Stanford University, Stanford, CA 94305-4055

January 13, 1998

IEEE Awards Committee
445 Hoes Lane
Piscataway, NJ 08855-1331

Dear Colleagues,

Endorsement of W.A. Gardner for Graduate Teaching Award

Professor Gardner has been known to me for about 30 years and I have copies of his books. He possesses absolutely first class ability to explain technical subjects and on top of that understands his subjects profoundly and contributes to their development. What is more, he can stand back and see the philosophical and didactic implications of the changing technical environment.

His book on *Statistical Spectral Analysis* is a marvelous example of the virtues of being skeptical, *as* Descartes taught us. If ever the cart was put before the horse, a prime example would be the elaboration of the theory of stochastic processes in contexts where the process is not known - only the data.

Professor Gardner has rectified the situation as regards graduate instruction in Electrical Engineering, bringing a healthy admixture of approaches into practice in Electrical Engineering Departments.

He is exactly the sort of person who will redound to the credit of the IEEE on receiving the Award for Graduate Teaching. It is an honor to support his nomination.

Sincerely,

Life Fellow IEEE
and Heinrich Hertz medalist

Tel: (650) 723-3545 **Fax: (650) 725-7126** **E-mail: bracewell@star.stanford.edu**

Columbia University in the City of New York *New York, N.Y. 10027*

HENRY KRUMB SCHOOL OF MINES Seeley W. Mudd Building

January 18, 1998

Graduate Teaching Award Committee
Attn.: Kerry Ann Ward
IEEE
Awards/Fellow Activities
445 Hoes Lane, P. O; Box 1331
Piscataway, NJ 08855-1331

Dear members of the IEEE Awards Committee:

I am happy and honored to write this letter in support of the nomination of William A. Gardner for the IEEE Graduate Teaching (Technical Field) Award for 1988.

From time to time, it is good to look back and see in perspective the work of those people who have made a difference in the engineering profession. One of the important members of this group is William A. Gardner. I have followed his work and have been in contact with William since his days as a doctoral student at the University of Massachusetts. He has now completed twenty-five years of service at the University of California, Davis, with an outstanding record of achievement. During this period, I have seen him develop entirely new avenues of research in spectral analysis, in digital communications, in electronic systems, and in the theory of random processes. His research contributions in these areas are impressive and are second to none. He has published a number of seminal papers and written several definitive books. All this is well known. What I want to emphasize here is his ability to produce excellent students who carry on and extend his work as well as to go into entirely new fields.

Professor Gardner has an active scientific imagination that lets him inspire students so they can attack difficult problems. As a teacher, William is interesting and challenging, always bringing out the latent capabilities of his audience. The students like him, as he is enthusiastic about what he does, cheerful and good-natured, yet hard-working and realistic. William has that extra "something" in the classroom, which makes him ideally suited in his role as a professor. Because he can do both theoretical and applied work, he has trained a distinguished group of students who can do the same. His students have received recognition at universities and in industry worldwide.

Professor Gardner has the ability to impart a fresh approach to many difficult problems. William is one of those few people who can effectively do both the analytic and the practical work required for the introduction and acceptance of a new engineering method. His general approach is to go back to the basic foundations and lay a new framework. This gives him a way to circumvent many of the stumbling blocks confronted by other workers. William has the knack of teaching students how to use the existing body of engineering knowledge, and also how to discover new methods of doing things. He gives to his students the ways and means of acquiring independent powers of investigation. William reaches out and bestows to each of his students those attributes which allow the student to attain success and honor in his career.

I am particularly impressed by the fundamental work in spectral analysis done by Professor Gardner. Whereas most theoretical developments make use of ensemble averages, he has gone back and reformulated the whole problem in terms of time-averages. In so doing he has discovered many avenues of approach which were either not known or neglected in the past. In this way his work more resembles some of the outstanding mathematicians and engineers of the past. This approach took some courage, because generally people tend to assume that all the basic work has been done, and that no new results can come from re-examining avenues that had been tried in the past and then dropped. William's success in the approach shows the strength of his engineering insight. He has been able to solve problems that others have left as being too difficult. It is this quality that he so well imparts to his students, who have gone forth and solved important and far-reaching problems in their own right.

Professor Gardner is a person of high ethical and moral standards and has brought credit to the entire engineering profession. He has imparted these same high standards to his students who carry on his work.

I highly support his nomination.

Sincerely,

Enders A. Robinson

Enders A. Robinson
Maurice Ewing and J. Lamar Worzel Chair in Geophysics
Member of the National Academy of Engineering

UNIVERSITY OF MASSACHUSETTS
AT AMHERST

College of Engineering
Amherst, MA 01003

Department of Electrical
and Computer Engineering

January 16, 1998

To IEEE Graduate Teaching Awards Committee:

I enthusiastically endorse the nomination of Professor William A. Gardner for the 1998 IEEE Graduate Teaching Award. Keeping in mind that the committee will concentrate on the teaching aspects of Professor Gardner's career, rather than on specific research contributions, I will focus *my* comments upon two areas in which I feel he has excelled, to an extent considerably beyond other graduate-level engineering professors. These areas are: (1) the quality of his research publications, and (2) the impact on the careers of the graduate students who have completed their graduate degree requirements under his supervision.

Background -- I have been acquainted with Bill Gardner for over thirty years, starting with his joining the technical staff of Bell Labs in 1967. In 1969, I left Bell Labs to become a faculty member in the Electrical Engineering Department of the University of Massachusetts. Bill left Bell Labs at that time and became a Ph.D. student at UMass, working under my supervision on the topic of cyclostationary random processes with particular emphasis upon their applications in communication systems. He finished here in 1972 and took the faculty position at University of California, Davis. Since that time, I have maintained a continual contact with him and his research activity. Of particular relevance here, because of a number of visits to UC Davis as well as numerous conferences and workshops, I was able to meet with and discuss research projects with many of his students. One visit was of an extended nature: I spent one term of a sabbatical leave in 1985 at UC Davis and was able to meet with his students on almost a daily basis. Another excellent opportunity to talk with current and former students was at the workshop on cyclostationary processes held in Yountville in 1992.

Quality of technical publications -- I believe I have read a major portion of Gardner's papers and textbooks. I feel that a unique feature of all these publications, compared to other engineering documents of a similar nature, is the presence of a strong scholarly style. Previous contributions to the topic are meticulously sought out and referenced. It's not just a matter of being polite to colleagues or avoiding confrontations over omitted citations; but a genuine attempt to establish an important historical context for new results or interpretations. The relevance of prior contributions to the topic is carefully

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laid out and unified. In this sense, I feel that all of Gardner's publications are tutorial to some degree. On the other hand, I don't mean to minimize the significance of Gardner's basic research contributions. On the topic of cyclostationary processes, I feel that he has, almost single-handedly, developed the theoretical and applied engineering aspects of the topic to the point of todays widespread recognition of its utility.

Impact on graduate students -- In informal discussions with many of Gardner's M.S. and Ph.D. students, I am greatly impressed with the unanimity of their regard for him as an inspirational teacher who has influenced their graduate studies and their subsequent careers. He seems to have a real talent for transmitting his own enthusiasm for research discoveries to those who work under his supervision. This seems to come about by posing challenging problems, but then following up with a ready availability for discussion, advice, and encouragement. It is interesting to note that several of his students have continued a research affiliation, in one form or another, with Gardner after graduation. I also notice that some of his students have adopted the scholarly writing style discussed above.

In summary, I feel that Professor Gardner is exceptionally well qualified for the Graduate Teaching Award.

Sincerely,

L. E. Franks
Professor Emeritus

UNIVERSITY OF CALIFORNIA, DAVIS

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DAVIS, CALIFORNIA 95616-5294

January 9, 1998

IEEE Graduate Teaching Award Committee
Awards /Fellow Activities
445 Hoes Lane, P.O. Box 1331
Piscataway, NJ 08855-1331

Dear members of the IEEE Awards Committee:

As Chair of the Department of Electrical and Computer Engineering at UC Davis, I am delighted to be given the opportunity to nominate Professor William A. Gardner for the IEEE Graduate Teaching Award. During his entire 25-year academic career in our department, Bill Gardner has worked tirelessly to enhance the quality of our graduate program. He is directly responsible for the creation and development of four of our current graduate courses: EEC260 (Random Signals and Noise), EEC262 (Spectral Analysis), EEC263 (Optimal and Adaptive Signal Processing), and EEC264 (Estimation and Detection of Signals in Noise). More generally, he has had a strong influence on our entire graduate curriculum in Signal Processing and Communications, and currently serves as coordinator for this area on the Graduate Program and Research Committee of our Department.

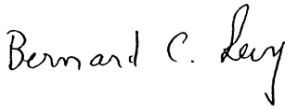
As part of his course development activities for EEC260, Dr. Gardner wrote a textbook, *Introduction to Random Processes with Applications to Signals and Systems,* as well as a solutions manual, which makes it possible to study the course materials in a self-paced manner. In addition to its scholarly and rigorous style, Dr. Gardner's random processes textbook has several original features which make it stand out among all other textbooks in the same general area. First, it contains a chapter on cyclostationary processes, which have been one of the main topics of research for Dr. Gardner throughout his research career. These processes play a key role in the study of digital communications systems, and virtually all recent digital communications textbooks refer to Dr. Gardner's random processes book, as well as to his research papers on cyclostationary signal processing. Another original feature of Dr. Gardner's random processes book is its detailed development of the time average approach for evaluating the statistics of random signals. This approach provides the theoretical underpinning for the textbook *Statistical Spectral Analysis: A Nonprobabilistic Theory* which was written by Dr. Gardner for his Spectral Analysis course (EEC262). Because of its revolutionary time-average approach (which can be traced back in part to the pioneering work of Norbert Wiener on generalized harmonic analysis), this textbook has been the subject of entertaining exchanges in the Signal Processing Magazine of the IEEE Signal Processing Society. As a consequence of Bill Gardner's courage and vision in pursuing a radically new path, based on the eminently sensible view that the analysis of random signals should be based on statistics extracted from the observed data, this book has had a huge impact on modern spectrum analysis practitioners. The letters by former students of Dr. Gardner attached to the present nomination clearly attest to the significant

influence of this book on their professional development.

Neither the ECE Department nor the College of Engineering at UC Davis have graduate teaching awards. However, the awards received by his students for their Ph.D. research provide a powerful indication of Dr. Gardner's outstanding performance as a mentor to graduate students. Specifically, Dr. Stephan Schell received the Anil K. Jain Award for the best Ph.D. thesis in the ECE Department in 1991, and Dr. Chad Spooner received the 1995 Allen G. Marr Prize recognizing the best Ph.D. thesis in mathematics, engineering, and the physical sciences at UC Davis in the previous five years. Previous Ph.D. students of Dr. Gardner, such as Dr. Brian Agee and Dr. William Brown, who graduated prior to the institution of the Anil K. Jain Award by our Department, would have certainly been strong contenders for this award if it had been in existence. It is also worth mentioning that the current group of Ph.D. students supervised by Professor Gardner is truly outstanding, so that Dr. Gardner's effectiveness as a research mentor shows no sign of abating. This effectiveness is also evidenced by the high degree of professional success that former students of Bill Gardner have been experiencing after graduation, many of them as entrepreneurs in wireless communications and signal processing startup companies.

Dr. Gardner's entire professional career embodies the teaching and graduate mentorship qualities that the IEEE Graduate Teaching Award recognizes, and it is with great enthusiasm that I nominate him for this award.

Sincerely yours,



Bernard C. Levy
Professor and Chair

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DAVIS, CALIFORNIA 95616-5294

January 23, 1998

Professor Bernard Levy
Department of Electrical & Computer Engineering
University of California
Davis, CA 95616

Dear Bernard,

I am pleased to endorse your nomination of Professor William A. Gardner for the IEEE Graduate Teaching (Technical Field) Award for 1998. As both a student and faculty colleague, I am able to provide a unique perspective on his accomplishments.

As a graduate student beginning in 1972, I took courses from Bill shortly after he began his academic career at UC Davis. Even at this early stage, he was an excellent graduate-level teacher. He quickly took a group of us from the fundamentals to the cutting edge of research developments in statistical signal processing, introducing us to emerging concepts in cyclostationary processes. He continually stimulated our thinking and challenged us to master very complicated material. He demonstrated an incredible dedication_ to learning and had a remarkable facility for communicating his deep insights on his research.

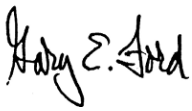
While he was not my major professor, he was a member of my dissertation committee. He reviewed the drafts of my dissertation with painstaking care and gave me guidance and encouragement that led to significant improvements in my work in image processing, outside his area of specialization.

As a faculty colleague for over 20 years, I have enjoyed observing his development as a teacher, mentor, and scholar. The voluminous hand-written notes that I read as a student have been developed into several excellent textbooks. He has led the development of a strong graduate program in signal processing and communications and has created and developed the four core courses in this program. He has consistently taken the best and brightest of our graduate students and has taught, mentored, and challenged them to become extremely effective, productive researchers. The many awards his students have received for their dissertation research attest to his immense skill as a mentor. Many of these students have since become entrepreneurial leaders in the fields of statistical signal processing and wireless communications.

Bill has served as an inspirational teacher for me and for many subsequent students. I

endorse his nomination for this award with great enthusiasm.

Sincerely,



Gary E. Ford
Professor and Vice Chair for
Undergraduate Studies

1009 Aster Avenue
Sunnyvale, CA 94086

January 10, 1998

Dear IEEE Awards Committee Members:

I am pleased to endorse Dr. William Gardner's nomination for the IEEE Graduate Teaching Award. As the most influential instructor in my graduate studies, he exemplifies the qualities sought in the recipient of this award.

Dr. Gardner's enthusiasm for research is contagious. I switched my emphasis and joined his research group after I took my first graduate course from him. He gave me direction that I had been lacking in my graduate studies, and was able to motivate me by emphasizing my strengths and expanding my interests. His persistent attention to the fundamentals provided a focus for my work and taught me a rigorous approach to engineering. Further, he fostered an atmosphere of collaboration among his graduate students which continued beyond the academic setting.

Dr. Gardner's courses are some of the most thorough and cohesive ones taught at the university. His books are extraordinarily lucid and relevant, and the associated exercises solidify the underlying principles. He ties his lectures, texts, and exercises together to demonstrate an incredible command of the subject and a genuine concern for the education of his students. Most importantly, he teaches an approach to learning that can be applied effectively in any other course or area of study.

Dr. Gardner has gained a well-deserved reputation for preparing graduate students for industry. His emphasis on the fundamentals has provided me a variety of opportunities since receiving my MSEE in 1990. His dedication to educating his students exceeds the normal engineering curriculum to include ethics, critical thinking, technical writing, and communication skills, all of which have been instrumental in furthering my own career.

I occasionally have the opportunity to work with Dr. Gardner in my current industry position. I look forward to these encounters because I know that I will gain additional insight into our common areas of interest. His influence as an inspiring mentor is one of the backdrops upon which I weigh other things in my professional life. I wholeheartedly endorse Dr. Gardner to receive formal recognition for the qualities of which I have long been aware.

Sincerely,

Teri L. Archer
Senior Development Engineer
Signal Science, Incorporated

4D Research, Inc.

5 January 1998

Technical Field Awards Committee
IEEE Awards Board

Re: IEEE Graduate Teaching Award

Dear Members of the Awards Committee:

As a former graduate student of Dr. Gardner's, I enthusiastically recommend Dr. Gardner for the IEEE Technical Field Award for Graduate Teaching. All of my experiences with him, as a student in graduate courses, as a teaching assistant and co-instructor, as an MS student and then as a PhD student and collaborator, exemplify the standard to which all professors in the graduate program ought to aspire.

My experiences as a student in 3 graduate courses taught by Dr. Gardner, and later as a teaching assistant and co-instructor with him for these courses, consistently revealed him to be unique among all professors I have encountered in his sincere dedication to learning, understanding, and communicating the results of his current research and his deep insights into the theory and method of signal processing. Dr. Gardner's conviction, namely that the student's drive to learn is paramount, provides him with admirable persistence both in answering students' questions and in asking questions of the class to stimulate their own thinking processes. Gardner just doesn't give up asking questions. For the student who seeks to learn, as well as for the student who is leaning that way, Dr. Gardner's approach rallies the spirit to master some rather complicated and deep material.

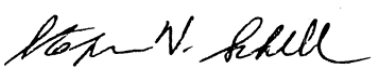
Dr. Gardner's textbook "Statistical Spectral Analysis" further illustrates his dedication to teaching. This text not only realizes the ideal of communicating deep theory by developing it as the solution to practical *engineering* problems, it also realizes the ideal of smoothly integrating an entirely new body of current research results into the curriculum by showing how these results, too, are solutions to practical engineering problems that follow naturally from the previous ones. Gardner's achievement in this regard is of fundamental importance to the relationship between signal processing and the ever-growing field of communication systems, because it provides a complete theoretical framework in which measurements, explanations of phenomena, and physical-layer designs for new communications systems can be performed, understood, and communicated. More than 10 years later, Gardner's text is still the best communication of the state of the art in spectral analysis for engineers involved with communication systems.

4D Research, Inc. • 860 Napa Valley Corp. Way Ste S • Napa CA 94558-6281 • (707) 226-2288 • Fax: 226-8877

In a vein similar to the above comments on course instruction and curriculum development, I found Dr. Gardner's commitment to, and direction of, his graduate students to be exemplary. The graduate student's mission is to learn and understand his field, perform original and creative research, and communicate the results. Gardner's consistent emphasis on this as well as his embodiment of it was extremely effective for me. Having total access to him as my advisor during my 4 years of graduate work, I aspired to his standard, grew under his mentoring, and eventually evolved into a collaborator of his and a professional in my own right, full of ideas and a conviction to develop and communicate them. It is an understatement to say that those 4 years under Dr. Gardner's guidance represented the time of my life in which I enjoyed the most fundamental and satisfying intellectual development.

I enthusiastically recommend Dr. Gardner for the IEEE Technical Field Award for Graduate Teaching. He embodies the description of the award and provides a high standard for others to aspire to.

Sincerely,



Dr. Stephan V. Schell

CEO & Chief Scientist, 4D Research, Inc.

Winner of 1991 Anil K. Jain Prize for Best Dissertation in the Dept. of Electrical and Computer Engineering at UC Davis

Innovative Algorithms
78 Buchanan Street
Apartment 505
San Francisco, CA 94102

January 5, 1998

Dear IEEE Awards Committee:

I am writing to you in support of the nomination of Professor William A. Gardner for the IEEE Graduate Teaching Award. As a former student of Professor Gardner, I believe I can offer a unique and important perspective on his teaching accomplishments.

After obtaining a BS in electrical engineering from UC Berkeley in 1986, I enrolled in the graduate program of the Department of Electrical and Computer Engineering at UC Davis, intending only to earn my MSEE. As it turned out, I met Professor Gardner, studied under him for my MS, and then continued working with him, which eventually earned me a Ph.D. in electrical engineering in 1992. Why did I change my mind about my degree goals and stay on at UCD with Professor Gardner? It was largely due to his skill as an educator and mentor, a skill he has worked very hard to acquire and one that he has applied extraordinarily well to his graduate students. I believe that his skill as a graduate instructor can be attributed to three core values: (1) a continual striving for excellence, (2) an unfailing availability, and (3) a love of basic truth, unfettered by unnecessary abstraction.

I came into direct contact with the first two values during my first term at UCD, in which I had taken a course from Professor Gardner called Random Signals and Noise. He taught the course from his book, *Introduction to Random Processes.* The material was appealing in its own right, but the presentation in the text was unusually clear and yet concise. The numerous examples and the end-of-chapter problems were always revealing and well thought out. The highly technical nature of the material was somewhat at odds with the instructor, who came across as a mild-mannered rancher. He spoke slowly and clearly, and I always felt that he was simply providing me with a gentle reminder of the details of the material, rather than rushing through it haphazardly or grinding through it ponderously, like so many others do. The standard he set for the course was high: master the material. Yet he was always available for consultation during office hours and would meet you at other times if those hours didn't work. The bottom line was that he wanted the students to learn the material, and he wanted them to learn it well. I was hooked.

I learned about the third .value, which is probably the most important one for modern graduate students, in a subsequent course I took from Professor Gardner called Statistical Spectral Analysis. The course was taught from another book written by Gardner, called *Statistical Spectral Analysis,* which contains many of his novel research results. The approach taken in this still-revolutionary text was unlike anything I'd seen up to that point. Although highly mathematical, the fundamental theme is one of making measurements on collected

data. As sensible as that theme sounds, it is absent from many textbooks on spectral analysis and signal processing. This was more like physics than electrical engineering, yet it was immediately applicable to real problems in engineering and science. I was amazed.

In all the facets of his teaching and research endeavors, Professor Gardner applies his values and the results are excellence and innovation. He applies them to writing, reading, and analysis with equal fervor. No student emerges from his tutelage without learning how to write clearly and effectively. Not only that, his students learn how to read and criticize other's writing as well. These skills are sorely lacking in many, many students at all levels and it is easy and tempting to follow the pack by ignoring their importance and letting it all slide. But Professor Gardner doesn't let it slide. I was lucky.

Throughout my academic journey, from kindergarten to Ph.D., very few teachers impressed me. But Professor Gardner has impressed me, and not just a little. He is the best teacher I've ever had, and he is the best graduate instructor I've ever heard of. I wholeheartedly endorse him for the IEEE Graduate Teaching Award. Whether or not he wins, I will be proud.

Sincerely,

Chad M. Spooner