

Foreword



A collection of papers, which are dedicated in honor of Professor P. R. "Pat" Sethna of the University of Minnesota on the occasion of his 70th birthday, are being published in this as well as some future issues of *Nonlinear Dynamics*. Professor Sethna has been an active researcher in the field of nonlinear vibrations and dynamics for nearly 40 years, making many fundamental and significant contributions to both the theoretical and applied aspects of this field. He is also recognized for his outstanding leadership and administrative abilities, amply demonstrated through his position as the Head of the Department of Aerospace Engineering and Mechanics at the University of Minnesota for 26 years (1966–1992).

Patarasp Rustomji Sethna was born on May 26, 1923, in Bombay, India, into a Parsi family. Economically, times were very difficult and the family had to manage with extreme frugality. As a student he was an inconsistent performer, but managed, with his father's constant insistence and prodding, to become the most decorated Boy Scout in India and the first in his extended family to attend college. He received his Bachelor's degree in mechanical and electrical engineering in 1946 from the College of Engineering, Poona. He was ranked first in the final exam and awarded the Rajadhyaksha Gold Medal in Mechanics by the University. Subsequently, he was awarded a full fellowship by the Tata's (the foundation associated with the prominent Indian industrialists) for higher studies abroad. As a young man, Professor Sethna had a strong interest in coming to the United States, the land of Lincoln and Jefferson. Thus, despite offers from several excellent European institutions, he chose to attend the University of Michigan because Roosevelt's opposition to colonialism appealed to a man raised in British India. Incidentally, he sailed for the United States a month before the British left India in August 1947. He completed his Ph.D. work

on multidimensional nonlinear oscillating systems in 1953. During his Ann Arbor days he met and married Shirley Sue Smith.

After completing his Ph.D., he worked as a Senior Engineer at the Bendix Aviation Laboratories in Detroit from 1953 until 1956, where he was initially assigned to analyze and design nonlinear suspension systems. The hardware implementation of his mathematically designed suspension system, optimized for absorption of impacts, was highly successful and it validated his belief in the power of theoretical tools in solving the practical engineering problems of society. Thereafter he worked on the dynamics of the whole vehicle. In 1956, he joined the University of Minnesota as an Assistant Professor. He was promoted to Associate Professor with tenure in 1959, and to full Professor in 1963. While on a sabbatical leave at Brown University in 1966, the sudden death of his Department Head, Professor Benjamin Lazan, and other prevailing circumstances in the Department, resulted in his being offered the leadership of the Department. He has believed ever since that it is important to choose leaders who do not want to be in charge, have little or no need for the job, and lack the ambition and hunger for power.

Pat and Shirley had four children: Son Jim is an Associate Professor of Physics at Cornell, son Michael is a Neurologist doing immunological research at Harvard, and daughter Susan is a Master of Social Work (M.S.W.) and Psychotherapist at the Hamm Clinic in St. Paul. Youngest son John has Down's syndrome and lives in a group home in St. Paul. In 1984, Shirley died after a long illness. In 1991, Professor Sethna met and married Marjorie Ford who is a professional artist.

His honors include election to Fellow of the American Society of Mechanical Engineers, Fellow of the American Academy of Mechanics, and Associate Fellow of the American Institute of Aeronautics and Astronautics.

Professor Sethna's career contributions have included a very successful 26 years as Head of the Department of Aerospace Engineering and Mechanics at the University of Minnesota. He took on this responsibility during a time of healing in which two departments (Aeronautical Engineering, and Mechanics and Materials) had recently been joined. Largely due to Professor Sethna's effectiveness as a recruiter and administrator, the Department flourished and is now the envy of many a department around the country. In fact, the faculty of 21 can boast of having three members of the National Academy of Engineering, and one who is a member of both the National Academy of Sciences and the National Academy of Engineering. During the 1980's Professor Sethna considered stepping down as Head, but stayed on to oversee the hiring of several young faculty members, who will now set the future direction of the Department. He saw this endeavor as his last major responsibility as the Head. He stepped down as Department Head in 1992.

Professor Sethna is held in the highest esteem by his colleagues at Minnesota. To quote from a recent endorsement letter by Professor William H. Warner, nominating him for a University of Minnesota service award, "he has created a humane atmosphere in which each of us has been encouraged to seek our own best, pursue new areas without fear, and work together as occasion allows without jealousy..... His own involvement in graduate teaching, advising and research throughout his tenure as Department Head has shown us that it is essential to be a scholar first and an administrator only after the first job is done." Another nomination letter by Professor Richard James expressed the sentiment "He is absolutely the most honest, farsighted, rational, unselfish, persuasive, tough and compassionate chairman I have ever met." Of him as a person, these sentiments are held by almost all of the faculty and staff in the Department, as well as those in the scientific community who have come in contact with Professor Sethna in any capacity over the years. He has always been kind and compassionate, and has given his honest and sincere advice to those seeking it.

Professor Sethna's scientific work has been at the forefront of nonlinear vibrations and dynamics research for nearly four decades. His Ph.D. thesis of 1953 was groundbreaking, as it was there that he pointed out the importance of internal resonances in weakly nonlinear multi-degree-of-freedom vibratory systems. Work on this general topic continues in earnest to this day. In the early 60's, he devoted much effort to classifying the response of systems based on the presence or absence of internal and external resonances. Among these classical works, his paper on systems with quadratic nonlinearities, which is one of the most cited references, completely characterizes the steady-state periodic solutions for such systems, and even anticipates the existence of amplitude modulated dynamics in damped and externally excited systems.

Throughout his academic career, Professor Sethna has believed in the power and usefulness of mathematical methods in the modeling and prediction of intricate physical phenomena, and has not shied away from their use, if convinced of their appropriateness for the problem at hand. He has been heard to remark on more than one occasion that he would be happy to generalize the existing mathematical results if they were inadequate for studying the class of physical systems of interest. In this vein are his non-local results which married the finite- and infinite-time theorems in the method of averaging. Toward this end, in order to formulate precise problem statements and proofs for relevant theorems, he had to compensate for his early unsophisticated training by continually learning new tools of analysis and differential geometry. He has also been known to be willing to conjecture the existence of required mathematical conditions, and then to go on to verify the analytical predictions with carefully planned experiments.

In the 1970's, he continued to work on internal resonances while also providing many significant new developments and refinements for the asymptotic methods used in the analysis of systems with different time scales. He applied these to a variety of physical systems including high-spin gyroscopic systems. He also investigated the ever-present and somewhat annoying question of the value of the small parameter for which the results of an asymptotic analysis are valid.

In the 1980's he turned his attention to the application of bifurcation theory in nonlinear dynamics and carried out seminal work in the area of dynamic bifurcations in the presence of symmetries. He applied these results to the motions of fluid-conveying tubes, surface waves in fluids and transverse vibrations of plates. It is of interest to note that, while Professor Sethna is generally viewed as being one of the more mathematically inclined engineers in this field, he was actively involved in several experimental endeavors. His observations of chaotic rotating waves in experiments on Faraday surface waves were instrumental in initiating several lines of analytical work which married his original research subject, internal resonances, to the most modern methods of global analysis. This recent work is an impressive use of very subtle and powerful mathematical techniques for describing the experimentally observed phenomena. Many of us strongly believe that, this ability to take the most difficult and sophisticated of mathematical ideas, and to translate them into a language which is easily understood and appreciated by the dynamics community, is one of his rare gifts for which we are ever grateful to him.

During his long and illustrious research career, he has continually maintained the utmost quality and scientific rigor in all of his endeavors. It is amply clear that but for his administrative commitments to the University of Minnesota he would have been able to accomplish even more in his research. His willingness to forsake some of his energies for administrative responsibilities is one more evidence of his selfless character and dedication to academic life. Professor Sethna has taken great pride and satisfaction, and even considered it his foremost duty, in the nurturing of young academics. He has served as a mentor in several capacities, as father, as Department Head,

as academic and research advisor for graduate students, and as an elder statesman to the dynamics community. He has been steadfast in his emphasis that scholarship and science are holy, and that one should not be distracted by the appeals of (departmental) power, (research) money or administration. He has taken great pride in the role of a public university as a means for educating the bright people from all walks of life.

He has freely given of his time and energy, and has always been available for personal and professional advice. This advice is rooted in fundamental principles, grounded in fairness and compassion, while upholding standards of the highest quality. Many of us have benefitted immensely from his wisdom, caring compassion and elderly advice, and for that we are forever indebted to him.

At the time of this writing, Professor Sethna is working with his son Jim and Professor William Warner on what he considers to be one of the most important research problems of his career: the use of asymptotic series, rather than power series, for the construction of normal forms. That he still becomes excited when discussing his research, while struggling with a severe illness, is a testament to his courage and passion. As quoted on the certificate presented to him on the occasion of his retirement,

"Pat Sethna is a man of wisdom, of a sympathetic and gentle nature, of courage, and of integrity."

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