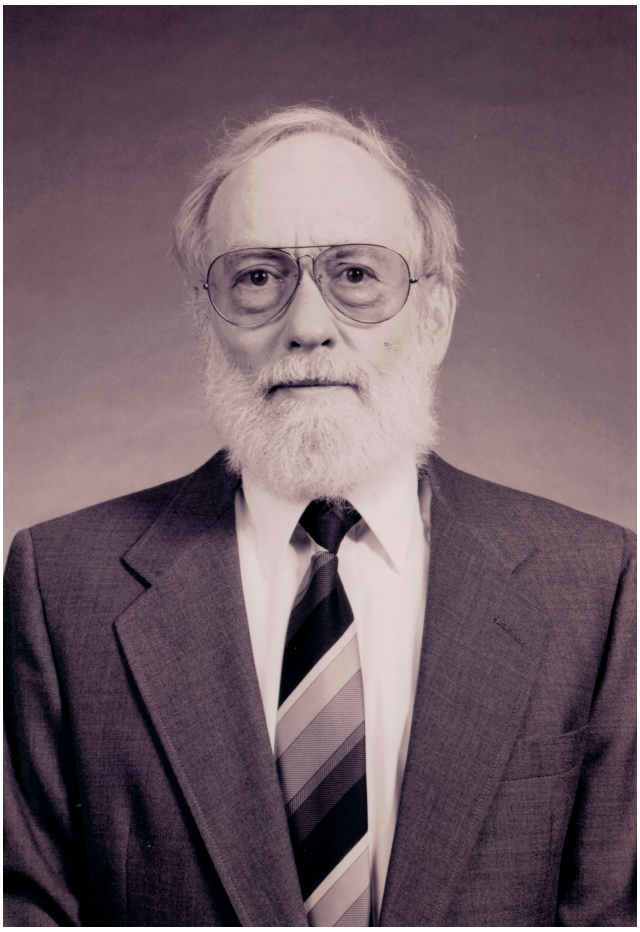
In Memoriam

Ward Cheney (1929 - 2016)



Elliott Ward Cheney, Jr., known to his friends and colleagues as Ward Cheney, passed away in Austin, Texas, on July 13, 2016. He was 87 years old. He is survived by his wife Victoria, daughter Margaret, and sons Elliott and David, their spouses Kevin Aldrich, Carey Cheney and Alexandra Fairfield, respectively, and three grandchildren. Ward's first wife and the mother of his children, Beth, died in 1991.

Ward was born on June 28, 1929, in Gettysburg, Pennsylvania, the younger of two children of Carleton (Pratt) and Elliott Ward Cheney, Sr. He earned his bachelor's degree in mathematics from Lehigh University in 1951 and his Ph.D. from the University of Kansas in 1957. Ward first worked at Convair Astronautics in San Diego, where his team did calculations for the computerized guidance system for the Atlas rocket. He also worked at Space Technology Laboratories in Los Angeles.

Ward spent the academic year 1961/62 at Iowa State University before joining the math faculty at UCLA for a couple of years. He was on the math faculty at the University of Texas, Austin, from 1964 until his retirement in 2005.

Ward was a prominent member of the approximation theory community. He was one of the original organizers of the Texas Approximation Theory Conferences and was an editor of JAT from its inception. He was a prolific author. His 1966 book *An Introduction to Approximation Theory* is a classic and still in print. His joint books with co-author David Kincaid are popular textbooks in numerical analysis and are well cited. Ward is a member of the inaugural class of AMS Fellows in 2012.

Below is a collection of reminiscences from Ward's colleagues, friends, and students, in which references, such as [22] and [B10], refer to the list of his published works in the section List of Publications of Ward Cheney.

Reminiscences of Ward Cheney

Johnnie Baker[1]

I initially made arrangements during spring semester in 1967 to do my dissertation with a professor in functional analysis, but changed my mind when he suddenly accepted an offer to spend the next academic year or two visiting NASA–Houston and Texas A&M. While considering my options, I noticed that a Professor Ward Cheney who I had never met had recently returned from a trip abroad and was scheduled to teach functional analysis during the fall semester. I decided to attend Professor Cheney's class in order to get to know him. After attending his class several times, I asked Professor Cheney if I could do my dissertation research with him.

Since I had no background in approximation theory and Professor Cheney did not plan to teach a course in approximation theory that academic year, I suggested I could learn material in this area as part of my dissertation work. Instead, Professor Cheney decided to look for an interesting problem that was related to functional analysis. At our next meeting, Ward suggested identifying a Banach subspace S of a $C(X)$ space such that any projection P of $C(X)$ onto S would have a norm larger than 3. This problem was motivated by a strange and unclear result that involved measure theory. I remember initially feeling totally lost as to how I could make any progress on this problem. However, Ward continued to encourage me to keep playing around with various ideas during our weekly meetings. Once I started making some initial progress, the rest of the dissertation research was much easier by comparison. Without Ward's continuing encouragement and confidence in me, I suspect I might have suggested switching to another more accessible problem instead. I also used this approach for assigning a research problem where I could not initially see any clear starting point with a couple of my own doctoral students.

Towards the end of my first semester of active research under Ward Cheney's guidance, he nonchalantly asked me at one of our weekly meetings what I planned to do next year. I was totally thrown off by this question and answered that I assumed I would continue teaching classes at the university as a graduate assistant the following year. I frankly was concerned that perhaps Ward felt my research wasn't progressing fast enough or that my results werent sufficiently impressive. He then informed me that remaining at the University of Texas another year wouldn't

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be possible, as he felt that I would finish my dissertation before the next academic year started. My life plans changed more rapidly in those few minutes than I previously thought possible.

After I had obtained the major results for my dissertation, Ward suggested that I find the simplest example possible that illustrated my main result. In this case, I needed to identify the simplest Hausdorff space X possible where my results could produce an uncomplemented subspace of $C(X)$. At our next meeting, I quickly described the requested minimal example and thought that would be the end of this request. However, Ward next asked me to create a written description of this example to include in my dissertation. At the time, I found this to be a strange request, as the only reason I could see for including this particular example in my dissertation was that it might provide a simple example that my dissertation committee could more easily understand and visualize. However, Ward's wisdom in insisting on the inclusion of this example became evident in my future research, as this example motivated several additional research papers.

In spite of Ward's having identified an important project as my dissertation topic and his continual encouragement and suggestions, he told me that since I had done my research without his participating much, that I should list myself as the sole author of papers resulting from my dissertation. I tried repeatedly to convince him that his involvement with this research clearly justified his name being on these papers. This is an example of his generosity and promotion of his students. On the down side, I missed my chance at having a very low Erdös number of 3.

I accepted a position in the mathematics department at Florida State. My future wife, Oberta Slotterbeck, completed her dissertation in group theory at the University of Texas a year later and accepted a position in the mathematics department at the University of Florida. When we decided to get married a year later, we were told that we could not both be in the same department, as this would be a violation of the nepotism law in the State of Florida. We lived for a couple of years midway between the two universities, but found the 3 hour round trip between our home and our respective universities to be unacceptable. At that time, there were a large number of unemployed Ph.D. mathematicians and very few academic positions were available. However, with Ward's advice and help, I was able to obtain a position at Kent State University and my wife was able to find a position at a nearby high quality liberal arts college, Hiram College.

Eventually, my research interests led me to switch my research area to parallel computing in computer science and to create the computer science department at Kent State University. I found it difficult to provide Ward with a brief explanation of my research work regarding how synchronous (SIMD) parallel computers could provide a substantially simpler and lower complexity solution to a variety of problems including large real-time problems like air traffic control than was possible with asynchronous parallel computers. I have always regretted not being able to attend and provide Ward with an expanded overview of my current research at the conference which was held in his honor.

I always tried to have dinner at some local restaurant with Ward during my occasional trips to the Austin area. During the time that our daughter, Jonobie, and her husband, Jeff Ford, were in the graduate computer science program at the University of Texas, my wife and I were very pleased to have dinner at a local restaurant where our daughter and son-in-law could meet both Ward and my wife's

advisor, John Durbin. In 2015, while attending Super Computing 2015 in Austin, we contacted Victoria, Ward's wife, and David Kincaid about going out to dinner since Ward hadn't answered my emails to him. At a dinner arranged by Victoria for her, us, and David, I was much upset to learn of Ward's difficulties.

The world has certainly lost a brilliant mathematician who succeeded in having his students reach for the stars. He will always live on due to his students and his contributions to mathematics.

Debao Chen[2]

My family and I are very sad to know that Professor Ward Cheney passed away. I will always be grateful to Professor Cheney for providing me the opportunity to come to the United States and for serving as my PhD advisor. Under his supervision, from 1988 to 1994, I received an excellently rigorous training in mathematical research at UT Austin.

One thing I always appreciated about Professor Cheney was that he cared for my family and me on a personal level. He was happy for my daughter when she graduated from medical school, and when I moved to California a few years ago to be closer to her, he told me to always enjoy our time together. Professor Cheney will be missed by my family.

Professor Cheney was particularly interested in research problems such as strictly positive definite functions on spheres, optimal polynomial interpolation, and minimal projection. He provided a detailed and careful introduction to Kilgore's and Brutman's works to me. In 2004 we met at the International Conference Approximation Theory XI at Gatlinburg, Tennessee, to discuss the polynomial interpolation problem in detail, and determined our research approach. In 2007 we presented a paper ([95]) at the International Conference Approximation Theory XII at San Antonio, Texas, where we provided a generalization of Brutman's work and studied the Lagrange polynomial interpolation at a special class of sets of nodes. Each set of nodes corresponds to a real number parameter in a closed interval of the real line. Many well-known sets of nodes, such as zeros of the Chebyshev polynomials of the first and second kinds, Chebyshev extrema, and the set of equidistant nodes, fall into this class. The initial idea for our approach comes from a figure and the accompanying discussion from the Cheney and Light book [B10]. Before our work, people studied the polynomial interpolation at these sets of nodes separately, but we introduced a parameter that allowed the studying of polynomial interpolation at these sets of nodes simultaneously, thereby permitting a better understanding of such interpolation problem. We even found that if the parameters are slightly larger than the particular parameter, which corresponds to the Chebyshev nodes, the corresponding sets of nodes are closer to the optimal set of nodes, although the optimal one is not in our special class.

Professor Cheney always carefully read our manuscripts and made invaluable suggestions. He encouraged me to continue my research in this direction.

Murray Cohen[3]

I was a classmate of Ward's from 1st to 8th grade. The schoolrooms had fixed desks, so that I was almost always seated directly behind Ward. It was natural to

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have conversations with him, and we were frequently in trouble for talking out of turn. I always remember him as being smart and a bit feisty.

Ward wore long stockings with short pants after the rest of us had graduated to knickers, and knickers after the rest of the boys graduated to long pants.

I played the piano and often played on the Cheneys' upright piano after school hours. I remember Ward starting to play the clarinet, and he sometimes played in school assemblies in our grammar school auditorium.

On some Saturdays, Ward and I and three of our friends would go on hikes to Point Mountain with our lunches. We had one adventurous time discovering an old abandoned copper mine that was just large enough for us to crawl in and explore. Ward was the first to volunteer to enter.

When it came to schoolyard fist fights, Ward was no slouch. He was small but fast and tough, so that even some of the bigger kids couldn't best him. If he didn't think he could win, Ward could run fast enough to stay out of trouble.

My parents used to go to Florida in the winter, and my brother and I would be boarded by Mrs. Harper, who lived next door to the Cheneys. One spring evening I looked outdoors and saw two giant streaks of light spread across the sky. I knocked on the Cheneys' back door because I knew Ward's father was a scientist. When he came to the door I almost shouted that there was a comet crossing the sky. Ward, his dad, and grandfather came out and looked at the sky in wonder. We all stood there contemplating it and then we went back indoors. The next day Ward told me that it wasn't a comet but the Northern Lights.

Ward came from a very intelligent and articulate family, his father being a physicist. I was often surprised at the amount of information Ward had as a young boy. He didn't volunteer it. You had to get into a topic with him, and after that, information of a second and third order would emanate. For example, when I was in the third grade, I became interested in astronomy and started to learn about the planets. Ward already knew all the planets from Mercury out to Pluto, how many miles they were from the Sun, as well as comets and the asteroid belt.

Ward also knew who Einstein was, his accomplishments, and also that Einstein was Jewish, which I believe caused him to have no trouble with my Jewish heritage. With my other friends, there was always the feeling of not being accepted in their social life, such as not being invited to their birthday parties, after coming to mine. But I never heard a disparaging remark about the Jews from Ward.

Every Friday there was an assembly in the auditorium, and it was the 6th grade's turn to put on a program. Our teacher Mr. Davis decided it should be a science program. I asked Ward what he thought I should demonstrate. He suggested the principle of the pendulum, in which the length of time it completes its cycle depends on the length of the string and not on how large the mass or amplitude of the arc. Ward's demonstration involved a milk bottle, a peeled hard-boiled egg, and some bits of paper and matches. He showed the students how the egg was too large to fit through the mouth of the milk bottle. Then he dropped in the paper and a lighted match and replaced the egg. The egg danced for a moment as the hot air escaped. Then you could hear a whoosh as the egg went through the opening, and a plop as it hit the bottom. The students gasped and applauded, and Ward had a mischievous grin.

Ward left the 8th grade and moved to Bethlehem, Pennsylvania, when his father became a physics professor at Lehigh. I was really sorry that my friend was moving

away. We didn't see much of one another after that, but I still carry lots of memories from our time at school together. Ward was a bit different than the other kids, and a lot of that was due to the wonderful home environment given by his dad and mother.

Allan Feldstein[4]

My last email exchange with Ward was about six years ago. He had asked me to referee a manuscript that was related to some of my research. I had already retired from academia several years earlier.

Ward was four years older than I am. He was a young, new faculty member at UCLA when I was completing the final items for my dissertation. Grad school had been delayed for me because of my Korean War service, and because I had worked at Los Alamos for three years.

Ward was very kind to me during my grad school. One important kindness was that he invited me to talk about my dissertation research to his numerical analysis class. That was especially opportune because it gave me a captive audience of exactly the right kind of people at exactly the right time. For an entire week, we all were able to address the various issues that I had researched. Basically, Ward and his class helped me debug my work – to be sure that it had no errors. Fortunately, all was fine.

Fifty-two years ago, Ward was an enthusiastic mountaineer. In this vein, he taught me how to exercise and strengthen my legs. He advocated not using the elevator and ascending the stairs quickly, two at a time. Ward, I greatly appreciate the many nice things you did for me over the years.

Carlo Franchetti[5]

It was July 1975 when in Austin, Texas I met Ward Cheney for the first time. I was on a sabbatical leave and I had been invited by Ward Cheney at the UT in Austin as a visiting scholar. I was 32 and Ward was 46 at that time. Upon my arrival, I and my wife Adriana were received very warmly by Ward and his wife Denise. His help was precious when dealing with practical issues, and he introduced me to the American way of life. I stayed in Austin till the end of spring 1976. It was a pleasure to work with him and our collaboration, I believe, was fruitful. Beside mathematics, we shared our common love for the "joy of running", often in the beautiful Austin's stadium, and the four of us had many dinners together. I also had the thrill of flying with him on a small Cessna (Larry Schumaker was the pilot). Ward was my guide in understanding the States, and thank to him in my 9 months leave I hardly had a boring moment.

After my return to Italy, we met again in Florence during the summer, because Ward and Denise came to Italy to visit Florence and Perugia. Later we resumed our collaboration two more times as I was back in Texas for 9 months in 1979-80 and for 5 months in 1983. Ward came other times to Italy attending meetings. Maybe I was not as good a guide as him, or perhaps he found Italy too "latin": indeed I had the impression that he was not overly enthusiastic about the country. He seemed happier in the UK, where he worked with our colleague Will Light (who died prematurely in the year 2002). It is not surprising that he loved Great Britain: he shared with his ancestors a good sense of humor, and certainly appreciated a

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more sober behavior. Ward approached every day with enthusiasm. He was skilled at recognizing the best course of action, but at the same time patient in difficult times, and he accepted the unavoidable setbacks of life without getting discouraged. He was a faithful friend and a kind person with everyone. In some sense, he appeared to me as an expression of the "American dream".

He loved music and he himself played the clarinet. Ward had also a reputation of being "wise", the kind of person you can rely on when looking for advice. I do not remember having seen him nervous not to say angry. Ward was methodical, systematic in keeping record of his house administration and of his daily duties. As a researcher he was able of keeping track of all useful remarks and notes, all previously obtained related results were perfectly ordered so that no step already made got lost. All this is very important in doing research. Indeed I was never able to work this way, thus for me meeting him was certainly good luck!

Finally all I can say is that having enjoyed the friendship of Ward Cheney was for me a great privilege.

Manfred v. Golitschek[6]

My first contact with Ward Cheney was a letter in which he invited me to visit the University of Texas at Austin. Supported by two grants of the DFG (Deutsche Forschungsgemeinschaft) I gratefully accepted this opportunity to work for a few months in 1977 and later in 1981, at one of the important centers of approximation theory, close to Ward, George Lorentz and Larry Schumaker. Ward introduced me to one of his favourite topics at that time: the approximation of a bivariate function by the sum of univariate ones. He was always very friendly and generous in sharing with me interesting mathematical problems, ideas and time. Therefore, it is of no surprise that we published our first joint paper in 1979 and two more papers in 1983.

In 1980, at the Third Texas Meeting at Austin, Ward introduced me to Will Light with whom Ward had started in 1976 a very successful collaboration that lasted until Will's sudden death in 2002. I am indebted to Ward for introducing me to Will. Will and I had also a fruitful collaboration that lasted until Will's death. Ward loved to visit Will in England, and did that on numerous occasions, first at Lancaster and later at Leicester. Perhaps, this is why I could never persuade him to become a visiting professor at the University of Würzburg.

I will always remember Ward with gratefulness and deep affection. He had an important influence on my personal life and on my fields of interest in mathematics.

Rong-Qing Jia[7] **and Junjiang Lei**[8]

We were deeply sad to hear that Ward Cheney passed away. The community of approximation theory lost an important leader.

We learned the name of Ward Cheney through his book "Introduction to Approximation Theory". This book was translated to Chinese in 1981. It had remarkable influence on Chinese graduate students and young mathematicians in the 1980's. Even today this book is still a valuable resource for the classical part of approximation theory. His other book "Numerical Mathematics and Computing", written

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jointly with D. Kincaid and published in 1980, is outstanding among many books on numerical analysis.

In 1989, when Lei began to write a Ph.D. thesis at the University of Oregon, we received a paper by W. Cheney and W. Light entitled "The Fix-Strang Theory for Functions Having Non-compact Support". Before their paper the research on approximation by translates of one or several basis functions mainly focused on functions with compact support. However, many interesting functions in applications, such as band-limited functions and radial basis functions, do not have compact support. The paper of Cheney and Light gave us much motivation. As a result, the main topic of Lei's thesis was approximation by multi-integer translates of functions having global support. Subsequently, we published several joint papers on this topic.

In 1991, with the help of Ward Cheney, Lei got an instructorship in the Department of Mathematics at the University of Texas at Austin. This gave Lei an opportunity to work closely with him from 1991 to 1993. Ward Cheney was a great teacher and mentor. He inspired young mathematicians by sharing his insightful ideas and discussing interesting research problems. It was always pleasant to collaborate with him. In 1992, Jia was invited by Cheney to visit the University of Texas at Austin and gave a couple of talks there. Today we still vividly remember the enthusiasm and hospitality of Cheney during that time.

The work of Cheney has a profound impact not only on the academic world, but also on the industrial world. After Lei moved to industry, he found that Cheney's books and research papers were frequently mentioned and acknowledged by many people working in the industry of information technology. Once Cheney and Lei had discussions about viewing quasi-interpolation from another perspective: integral operators. Many years later, Lei was inspired by these discussions and realized the significance and usefulness of Cheney's ideas in the field of computational lithography and in the integrated circuit chip making industry.

Recently the book "A Course in Approximation Theory" of Ward Cheney and Will Light was published by American Mathematical Society as a graduate textbook. This book covers many modern topics of approximation theory. It gives the reader an opportunity to explore contemporary approximation theory.

Ward Cheney left us with his tremendous contributions to approximation theory and related areas. His dignity, his kindness, and his insights will be kept in our hearts.

David Kincaid[9]

I can still remember the day, in the late 1970s, that I asked Professor Ward Cheney if I could drop by his office and chat with him about the numerical methods course that I was going to teach the next semester. It was a jointly listed undergraduate course in Mathematics and Computer Sciences at The University of Texas (at Austin). Ward Cheney was a faculty member in the Mathematics Department and I was working in the Computation Center and teaching in the Computer Sciences Department. We were both members of the Center for Numerical Analysis, that Professor David M. Young, Jr., had established. Because Professor Cheney was currently teaching that course, I thought it would be interesting to talk with him about it. I had never taken a class from Cheney or worked with him! I did know that he was known to be an excellent teacher. During the meeting, Ward

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gave me some of his notes and asked if I would be interested in working with him on them! I was totally surprised, but did say "Yes"!

I was not sure that anything would come from Ward's suggestion, but we turned them into our first book together. Over the years, we wrote a total of three textbooks together with a total of 7, 3, 2 editions! They are still in print and have been revised, updated, and reprinted many times. When working together, we most often did not actually meet face-to-face, but would mark up the pages with comments and suggestions, and put them, together with pages of new materials, in a folder left in the other person's mailbox.

Ward kept to a strict daily schedule. He lived near the university and every day of the week rode his bike to and from home and the university. At noon, he went to the gym on campus, and swam in the indoor swimming pool. Also, he would run a mile around the track of the large nearby university football stadium. Each day, he would keep track of his time for running a mile and record it on a 3×5 card. (We used some of this data in a problem in one of our books!) Ward had many exercise friends.

Usually, Ward taught a full-time load of both undergraduate and graduate mathematics classes. Moreover, he supervised many students doing mathematical research. Ward was an accomplished clarinet player and enjoyed playing with pianist Wanda Reynolds and cellist John Cox—who where members of Ward's chamber music trio. They got together to play classical music once a week.

It was an honor and a privilege to have worked with such a brilliant and kind hearted gentleman such as Ward Cheney. We became close friends over the years. I miss him greatly!

Jeremy Levesley[10]

Ward had a much bigger influence on my career than he might have imagined. I first met him in 1992 when he came to visit Will Light, his long-time collaborator and friend, at the University of Leicester. I had just finished my PhD in numerical conformal mapping and the solution of integral equations, but was struggling to prove the next "thing", in some sense, my first really independent results. At this time in my life, mathematicians who had written books I had read were celebrities, so the writer of one of the go-to numerical analysis texts, Kincaid and Cheney, was certainly in that category.

Since I was struggling, Will invited me to work with him and Ward, on a project with one of Ward's collaborators, Yuan Xu. I was both excited and full of trepidation at the idea of working with these two top flight mathematicians. One of the first things that was evident about Ward was his kindness he immediately made me feel as though we were equals in the endeavor. We continued to work through that year, finally producing my only co-authored paper with Ward, related to the construction of compactly supported radial basis functions via combinations of spherical averages of powers of the norm over spheres of different radii.

Ward was a fantastic craftsman in the art of writing. During the creation of our paper, he produced version after version of the manuscript, carefully hand-written. I think that Will developed this habit too from long-time partnership with Ward. What strikes me most about this, as I remember the experience, is the patience and care that was taken with the creative process. I think that this is a dying art perhaps, though I am sometimes struck that I think a lot better when I write by

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hand than I do when I type, and that I should invoke the spirit of Ward more often when I am writing papers.

Towards the end of his stay in Leicester we all went to the Chamonix approximation theory conference. This was my first conference presentation for approximation theory, and this was a new community for me. I can remember sitting in the hotel where the invited speakers were housed, talking with Will, Ward, and Xingping Sun. Will had said that he thought that I was in some way lucky to have got the job in Leicester (and I think that I was inclined to agree with him). Ward disagreed, and said that he thought I was fully deserving. This is my strongest memory of Ward. He may not have appreciated the impact of this statement on me. Here was a modern great of approximation theory endorsing my membership of the community. Many young academics suffer from "imposter syndrome", the continual fear that they are going to be exposed as not good enough. I certainly did. The generosity of Ward in recognising this and seeking to help me feel otherwise is testament to his sensitivity as a person, and kindness.

Ward also had a great sense of humour. When I first met him he already sported a long white beard, and I was immediately reminded of the old man in the pit that Brian landed on when hiding from the crowd in Monty Pythons Life of Brian. Of course, when I knew Ward better I mentioned this to him and discovered that he too was a big Monty Python fan. So we spent much of our time together discussing our favorite sketches. There is one negative mark from my point of view against his sense of humour, and that was he also loved Benny Hill.

It is said that the greatest mark of respect is mimicry, and I find myself aping Ward in some of the things that I do. One in particular is when people ask me for advice. I can remember asking Ward on a number of occasions, as I always found him to be considered and wise. He said to me, I will give you my advice but you must be aware that is worth exactly what you are paying for it – nothing. Of course the opposite was always true and, in my life, I have found that it is the people who value their own opinions too highly who are the ones that should be ignored. Ward was the opposite of this.

Another gift that Ward brought with him was his contacts. One of my long term and best collaborators is one of Ward's ex-students, Xingping Sun. Xingping is a perfect example of the excellent training Ward gave, and over the years we have always enjoyed our working together, and continue now to find excuses to meet up to make joint discoveries.

Ward continued to come to Leicester for a number of years and was with us when I got married in 1997. He came along to my wedding, and gave us a lovely mirror, which hangs in our hall to this day. One of my proudest moments was at the celebration of his 65th birthday in Approximation Theory VIII at College Station, and being announced as one of his coauthors.

Farewell Ward, I am honored to have known you – you have had a great impact on my and, I am sure, many other lives. You were a great mathematician, but, more importantly, a wonderful person. Rest in peace.

Dany Leviatan,[11]

I first met Ward at the annual meeting of the AMS in San Francisco in January 1968. I gave a lecture at the meeting which Ward had attended. After the lecture he introduced himself and I was so excited. Here was a guy whose book I had

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read and whose paper with Sharma from 1964, on the Bernstein power series, I had generalized. On top of that, Ward took me to meet George Lorentz who had also attended the lecture. Two such distinguished mathematicians attending my lecture, me being a couple of years after receiving my PhD, I was awed. In 1970 I found out that Ward was spending the academic year 1969/70 at Michigan State University, East Lansing, MI, not far from where I was (at that time, I was a Visiting Assoc. Professor at the University of Illinois, Champaign-Urbana, IL). So, I invited him over for a colloquium and we spent some time talking about approximation theory and my future plans. Ward took interest in what I was doing, gave me advice and encouragement, all at eye level, never giving the impression that he feels superior in any way. Ward invited me as Visiting Professor to Austin, TX for the academic year 1985/86 and, of course, we had a seminar in AT while I was there, together with G. G. Lorentz. I can add that in addition to our love for approximation theory, Ward and I also shared a love for sports, although Ward engaged in all of running, swimming and cycling, while I only swim. We would usually skip lunch and go together to swim at Gregory Gym on the UT campus. We met over the years at numerous conferences, in particular the Texas meetings, and Ward was always fun to meet with. He was always cheerful, smiling, generous, had a good sense of humor and people loved him. I had not seen Ward in recent years and was very saddened by the news about his Alzheimer's disease. Rest in peace my dear friend, I will miss you.

George Phillips[12]

I first met Ward Cheney at the first international conference I attended. It was held at the University of Lancaster in July 1969. I also met several other leading approximation theorists there, including Lothar Collatz, Philip Davis, Frank Deutsch, John Mason, Blagovest Sendov, Didi Stancu and Jozsef Szabados. The first moon landing happened during the period of this conference. Frank Deutsch and I watched it on television together.

Ward was already very well known in 1969. His important book *Introduction to Approximation Theory* was published in 1966. He was a superb communicator of mathematics, an exciting lecturer and a splendid writer. I approached him during the conference to ask him for help with a problem I was interested in. From memory he wrote down some references for me on the spot. I am a hoarder – I still have the notes he wrote out for me that day. He was so helpful and encouraging, and was such good company, so easy to be with.

Several years later, Ward came to visit us in St Andrews, and I visited him twice in Austin. One time when we were stuck with our research he said, with a happy chuckle, "I bet everyone knows the answer to this except us!" I also met Ward at several conferences, including three organized by Sankatha Singh and his colleagues, all funded by NATO. The first was held at St John's in Newfoundland in 1983, and the other two were held in Maratea, Italy in 1991 and 1994.

Ward was born in Gettysburg, Pennsylvania. One day he asked the question "Do you know Lincoln's Gettysburg address?" and indicated that he was going to supply the answer, which was: "I didn't know he had moved."

Ward had such a lot of research collaborations. His collaboration with Will Light was, alas, terminated after more than 20 years by Will's premature death in 2002. At the memorial service I heard the beautiful tribute written by Ward. He was

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not there. I guess he was too grieved to come. Strangely, Ward's absence seemed entirely appropriate. Goodbye, Ward.

Larry Schumaker[13]

The first time I met Ward was on an interview trip to the University of Texas in Austin in January of 1968. At the time I was just finishing up a two-year postdoc at the Mathematics Research Center at the University of Wisconsin in Madison, and was looking for my first real job. Although I had several other offers, the contrast between the cold snowy winter in Madison and the beautiful sunny weather in Austin made the choice easy. But the main draw of UT was the fact that Ward told me that he was planning on building up a group in Approximation Theory, and was also hiring George Lorentz that year. The group expanded a few years later with the addition of Hubert Berens and Jorg Blatter, so in the mid 70's we had a full five faculty doing Approximation Theory. It was in that time period (1973) that the group organized the first Texas Conference on Approximation Theory, which has been held every three years ever since (the most recent one being in San Antonio this year).

Ward was an exceptionally kind and gentle soul. He always had time to mentor a young faculty member, and we often discussed problems. But in the end we did not end up collaborating on any joint papers, even though we were in the same department for a dozen years. I had his students in my classes, and he had mine in his. Our interests were not close enough to result in any joint papers, but I highly valued those discussions. He became one of my best friends and most loyal supporters.

The 70's were a much more social time than these days, and there were departmental parties following colloquium talks practically every week. So we saw Ward and his wife frequently, and also met his family when the event was at his home. Ward had a number of interests outside of mathematics. He was a dedicated runner and swimmer, and every day instead of eating lunch he would be at the track or pool. He was also a dedicated musician, and played his clarinet in various chamber groups for his entire life. We often saw him and his wife at various concerts around Austin. For a number of years we also shared a sail boat which we kept on Lake Travis near Austin.

After I left UT for Texas A & M in 1980, and then in 1988 for Vanderbilt, I saw less of Ward, but we still met at meetings occasionally. The last time I saw him was in April, 2013, when he and David Kincaid attended the conference dinner for the Fourteenth Texas Approximation Theory meeting in San Antonio. He looked good, and seemed to enjoy himself, but I was sorry to see that he no longer seemed to recognize his colleagues. Ward played a major role in the development of Approximation Theory as well as in my own professional development, and I will miss him greatly.

Xingping Sun[14]

I first met Ward in the summer of 1983 while attending his Changchun lectures on modern approximation theory, taking place in Jilin University, Changchun, China. The lecture series organizers were Lizhi Xu and Renhong Wang. The main goal of the Changchun lectures was to assist graduate students in finding research topics

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for their theses, which was an eye-catching theme for graduate students interested in approximation theory. The early 80's are conspicuously interesting time in the modern history of China. After years of political and economic upheavals, the middle kingdom had just opened up to the outside world. Young people were as much dazzled as bewildered by what they heard and saw from the Western World. In particular, students in STEM fields realized that China was very much behind in scientific and mathematical research. During the cultural revolution (1966 -1976), young people were corralled to purify their political ideology. Critical thinking and independent inquiries were completely stifled. The open-door policy the paramount leader Deng Xiaoping implemented at that time lifted many flood gates. A great number of college students and graduate students alike poured their energy and enthusiasm into pursuing scientific and mathematical knowledge.

Ward's book "Introduction to approximation theory" was then a must-read for Chinese approximation theory researchers. Many referred to it as *the* book, which contains in its exercises many interesting but hard-to-solve problems. Not surprisingly, young and energetic students swarmed Ward during lecture break time to ask for clues or hints. Ward did not disappoint these eager and inquisitive minds. Most of the time, he elucidated the main ideas, and encouraged the students to work them out. Sometimes, he even wrote on the blackboard the solutions in details. Ward's lectures touched upon many research papers that were inaccessible in China those days. Upon his return to US, Ward immediately mailed copies of these papers to those who requested. I can still recall how thrilled I was the moment I received from Ward copies of two papers which I was eager but unable to acquire for a long time!

At the Changchun lectures, Ward was often surrounded by a throng of young students asking questions ranging from general mathematics to US politics. Many wanted the honor of having Ward's autographs on their copies of the Chinese translation of "the book". The scene was akin to a winning tennis star signing autographs. Years later, Ward fondly recalled his Changchun experience by saying: "I was treated like a celebrity which I have never aspired to be". He added: "It was my first time and possibly my last time to see so many young students so hungry for mathematical knowledge!" How true! China was enjoying a golden era of mathematical and scientific research. Famous mathematicians and scientists were perhaps the only kind of celebrities in the society. Unfortunately, that turned out to be an extremely short-lived phenomenon, lasting maybe five years! One wonders if such a thing would happen again before the end of time.

In Ward, young students saw for their first time an internationally well-known mathematician who was also full of modesty and humility, easy-going, and ready-to-help. It soon followed that many of them applied for admissions to US universities to pursue Ph D's in STEM areas. Ward paid application fees out of his own pocket for some applicants who had no other means to pay. He described his generosity as "an investment for the future of approximation theory". Without any questions, Ward's presence and lectures molded many young minds and changed some people's lives, mine included.

Ward led a vibrant and productive approximation theory research group in Austin in the 80's and 90's. Yuan Xu held a post doctoral position there from 1988 to 1991. Hubert Berens, and Will Light were among a few who spent their sabbaticals there. George Lorentz dropped by periodically during his retirement.

I joined the group in August 1986 as a student, and completed my Ph D study in August 1990 under the guidance and tutelage of Ward. Among Ward's other Ph D students were Valdir Menegatto (completed in 1992), Kuei-Fang Chang (completed in 1993), and Debao Chen (completed in 1994). An interesting and lasting research topic this research group carried out for over a decade was the characterization of strictly positive definite functions on spheres. Based on Schoenberg's characterization of positive definite functions on the unit sphere $S^d\,(d \geq 1)$ in $\mathbb{R}^{d+1}$, Xu and Cheney [77] introduced the notion of *strictly* positive definite functions on S^d, and showed that a function f of the form:

$$f(t) = \sum_{k=0}^{\infty} a_k P_k^{(\lambda)}(t), \quad t \in [-1, 1],$$

in which $\lambda = \frac{d-2}{2}$, $P_k^{(\lambda)}$ denotes the order λ Gegenbauer polynomial of degree k, $a_k > 0$ for all $k \in \mathbb{Z}_+$ and $\sum_{k=0}^{\infty} a_k P_k^{(\lambda)}(1) < \infty$, is *strictly* positive definite on S^d. Specifically for these functions, F. Narcowich and J. Ward [SIAM J. Math. Anal., **33** (2002), 1393–1410] later coined the terminology "spherical basis functions" (SBF), because they play the same role on S^d as radial basis functions (RBF) do in $\mathbb{R}^{d+1}$. Both SBF and RBF have important applications in various computing endeavors. In proving the above result, Xu and Cheney adapted the use of the addition formula for Gegenbauer polynomials, which can be dynamically interpreted as some coordinated continuous deformations from $[-1, 1]^{d+1}$ to certain sub-manifolds in $[-1, 1] \times S^d$. This deep topological connection reveals a couple of projection techniques for the purpose of characterizing strictly positive definite functions on S^d. Xu and Cheney utilized the axial projection part. Chen, Menegatto, and Sun [Proc. Amer. Math. Soc. **131** (2003), 2733-2740] used the "curvilinear projection" (projection to the equator), and established a necessary and sufficient condition for strictly positive definite functions: In order that f (as expressed in the above equation) be strictly positive definite on $S^d\,(d \geq 2)$, it is necessary and sufficient that $a_k > 0$ for infinitely many odd and even $k \in \mathbb{Z}_+$.

Daniel Wulbert[15]

Ward Cheney was my graduate advisor, my mentor, and my friend. Although Ward's research is the major influence on mine, his most significant influences on me are personal.

First let me set the context. I grew up in the Chicago inner-city where fewer than 30% of my high school class graduated, and less than one percent went to a four year college. Neither I, nor my friends, nor my immigrant parents understood what I was starting: what graduate school expected, what Mathematics comprised, or what constituted the life of an academic.

Ward came to the University of Texas about the time I came as a graduate student. We, graduate students, were in awe of him. He had a professional reputation of eminence. He played classical clarinet, and he had written a book that is still the most scholarly mathematics book accessible to undergraduates. His arrival marked a change in the direction of UT mathematics. He was 34.

He started my dissertation research by giving me a fountain-pen hand-written list of a few dozen questions–not necessarily profound. The off-shoots and trails spawned the dissertation. I came to his office at the end of every day, and told him

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whatever I had worked on the previous night. When something interested him, he would sit back, visibly settle in, and offer me a cookie from a desk drawer. My friends amused themselves with comparisons to Skinner's pigeons.

We went to Europe the next year. Ward was 36. I just turned 24 and his oldest child, Margaret, was maybe 14. I worked late every night, and every day we fused together any progress we made and then refocused our research accordingly. We swam in the Lund University pool; we debated most anything on a balcony in Lausanne (and would switch sides on another night). We wrote papers and started projects.

Ward's children, Margaret, David and Elliott; read novels, played Go with us on a quarter board, wrote formal proposals for permission to stay up late, and learned to ask in French to rent a rowboat. They found the swimming form that I lost from my competitive collegiate days. Now, one can see how that time previewed their maturing into the musical, active, intellectual people that Ward was so proud of. I also remain emotionally attached to them.

It was a marvelous year: a chance for me to see how to develop projects, but also how to progress from a graduate student to an "adult".

One dinner early in the year, Ward announced it was time for me to stop calling him "Professor Cheney"; that I had a doctorate, we were working together, and we were colleagues. I should call him "Ward". He said there was a Scandinavian ritual for this: the two people, with steins of beer, interlock drinking arms and quaff the beer. Even with the embarrassing failure to accomplish the ritual, I still felt pretentious using Ward's first name. Now, 50 years on, I still feel proud to have been Professor Cheney's student and privileged to call him a colleague.

Years later at a mathematics meeting – one at which I brought my four year old daughter who Ward entertained with multiple rides in the hotel elevator – Ward surprised me by mentioning it was my birthday. He answered my question, as to how could he know, by matter-of-factly saying, "You're special to me." He could have no idea I would cherish that kindness 40 years later.

For a year in graduate school, and for a year as a post doc, my mathematical idol was my personal mentor. Ward shaped my values about mathematics, commitment, and playfulness. In all the years after, we traded e-mails and teasing comments. But I hadn't seen him in ten years. I get to keep my memories of Ward as a youthful, vibrant, brilliant, mischievous man. I see him swimming in the pool; nimbly baiting us with spurious arguments; and meticulously drafting a paper with a Parker Sonnet pen.

I get to remember his epigrams such as, "All good mathematics is done at the kitchen table," or that you should thoroughly read a paper, "If otherwise your career will crumble." He referred to a mathematician's convoluted proofs as "cards held close to the chest." He taught me a sentence to say to German mathematicians after an Oberwolfach lecture – which I later translated as, "Did you have a good sleep?"

Ward – my mathematical father, my dear friend – I never told you – but I hope you knew – that I know your Erdös number is 2, and your birthday is June 28th.

Yuan Xu[16]

I first learned approximation theory from Ward Cheney's classical book of 1966 while working on my master degree at an engineering college in Beijing. The book

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had a strong impact on me, far beyond the beautiful mathematics between its covers, as the effect was magnified by force far greater. It happened in a unique time. Ward's book was translated into Chinese in early 1980s, shortly after China ended its disastrous "Cultural Revolution" that had closed universities for about ten years. It was a time of dire need for books in China, not just books that would bring in fresh air and break stagnation, but also books in sciences. Before I squeezed into my college, luckily, at the first chance when the door reopened, I had worked as a farmhand on a collective farm for four long years, sent there right after my much curtailed high school. My master degree program was heavily on spline functions and their applications in CAGD, befit for an engineering college. As it was, I had little idea what research in mathematics meant. Ward's book was the first research monograph I encountered, it opened the door to a whole vista hitherto unknown to me.

Ward offered me my first academic position, a PostDoc in UT Austin, in 1988. Being restless and still searching for a purpose in life, which was my main reason for moving out of China, I applied for jobs in the *third* year of my graduate school at Temple University, not knowing how reckless that was – ignorance is bliss. Imagine my surprise when I received a phone call from Ward Cheney on a Spring day, and he told me that UT would offer me a position! In a gentle voice, he said that he was required to call to make sure that I could teach and he was satisfied. Although I could hardly teach at the time (not yet taught any class in English), UT made me an offer. Only years later did I comprehend how lucky I was.

I first met Ward in his office, on a hot day in the middle of August, 1988. Instead of the lofty professor in my mind's eye, I met a bearded man dressed in shorts, but a gentleman he truly was. Ward was kind and gracious, treated me as a colleague from the beginning, despite the gulf between us, and insisted being called Ward instead of Professor Cheney. He helped me get started on my first job. When I asked him what he expected of me, he did not give me a topic but suggested that we should restart the Approximation Theory Seminar in the department, which we did. For my first year in UT, I was busy with teaching, or learning how to teach, and continued some work along my thesis. Ward did not put any pressure on me, just let me be myself.

At the beginning of my second year in UT, Ward introduced me to radial basis functions, a hot topic back then, riding on Micchelli's influential paper on interpolation by positive definite functions and a flow of preprints pouring out of Powell's group in Cambridge. Ward went to the root of the subject, started from Schoenberg's classical papers around 1940's and traced down many articles on the topic. I still have some of the Xerox copies of those papers, yellowed by age, that he copied in the library and passed on to me. Ward spent much time reading the papers, his copies were lined and marked, with notes in the margins. Before the end of the Fall term, we decided to try our hand on strictly positive definite functions on the sphere, motivated by scattered data interpolation and Schoenberg's characterization of positive definite functions on the sphere. Over the winter break, I found a sufficient condition with a rather long proof. Ward verified it and saw a short cut that reduced the length of the proof substantially. The result is [77]. Soon after we finished that paper, Will Light came for a short visit and Ward introduced me to him. By the end of the summer, we had an active program going, which led to several papers, one of which was joint with Jeremy Levesley.

Ward was generous with credit, especially when working with young people. After we finished [77], he insisted that he should be the second author because he "did not need it anymore" and would not change his mind. The pattern continued in our other joint papers: author names were ordered according to reversed seniority, unless the paper appeared in the proceedings of some conference that Ward was invited to attended, for which reversing the order of author names would not be appropriate.

It was fun to work with Ward. He had good taste and was a superb writer, meticulous and with style. He wrote and maintained a file named "Suggestions for Writing Reports, Theses and Dissertations" for math graduate students at UT Austin, full of valuable advice and suggestions. Reading it improved my writing substantially.

Ward was a perfect mentor, easy to engage, friendly, and generous with his wise advice. Looking back, my three years at UT shaped my career in many ways. It was in those years that I learned the trade of our profession, not just how to do research or how to write a paper appropriately, but also the nitty-gritty of the profession, in full spectrum, from how to compose a report to the internal mechanism of a department; much of it I learned from Ward. I often went to his office, one floor above my own, seeking help or advice and received plenty of both. In more than one way I felt like Ward's protégé and perhaps Ward thought so too. When I said goodbye to him before leaving Austin, his parting advice was "Take care of yourself, remember, institutions always survive."

We kept in touch over the years, and I sought his advice from time to time. He informed me of his retirement in 2005. The last time I wrote to him was in March, 2013 and I asked if we might meet in the next Texas Approximation Theory conference in San Antonio. His wife Victoria replied on his behalf with the sad news that Ward was suffering from Alzheimer's disease. Victoria forwarded my message to David Kincaid, who kindly drove Ward to San Antonio on the evening of the conference dinner. It was there when I met Ward for the last time, but sadly, he no longer remembered me. We cheered for him when Larry Schumaker announced his presence. He looked well and even happy that evening, so perhaps that was a fitting goodbye after all.

Ward was a great mathematician, a fine person, and a gentleman. He touched my life profoundly and had a hand in my fate in two deciding junctures, for which I am forever grateful.

Ward Cheney as a Father

Margaret Cheney[17]

I consider myself lucky to be the daughter of Ward Cheney. The following is an account, assembled by my two brothers and me with help from his wife Victoria, of what it was like to grow up with him as a father.

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FIGURE 1. Ward Cheney in his office at the University of Texas, circa 1970

1. Travel

One of my colleagues once jokingly refereed to university faculty as white-collar migrant workers. This was an apt description of our life as my dad took short-term visiting positions and sabbaticals. Over a span of 12 years, we lived in 16 houses in California, Texas, Iowa, Seattle, Michigan, Sweden, England, and Switzerland. We traveled extensively throughout Europe and learned that there is more than one way to live, talk, eat, and think. For example, in Sweden, we children learned to bow and curtsey to our elders, and when we arrived in our school classrooms, we remained standing behind our desks until the teacher gave us permission to be seated.

On our first trip to Europe in 1964, the plan was to land at the airport, pick up the VW our parents had bought, and drive to Oberwolfach. Nobody slept much on the airplane, and Oberwolfach was difficult to find; by the time we finally arrived, exhausted, it was past dinnertime at the Math Institute, and there was no way to get food. After that experience, Dad always arranged a hotel room in the city where the plane landed, with an extra day to recover from the plane trip.

When we traveled in Europe, during the period when we children ranged in age from about 9 to 12, we had ten suitcases among us. Each of us was responsible for carrying two particular ones, labeled with our initials. After every taxi ride Dad would stop and count to make sure we had all ten.

Later in life, when he traveled by himself, Dad would go to Europe for a whole summer with only a small bag containing a few changes of underwear and a few shirts, which he washed every night. Occasionally the airport security people would find this small amount of luggage suspicious and would pull him aside for questioning.

Besides European travel, we criss-crossed the United States by car: California, Pennsylvania, Iowa, Seattle, Texas, Colorado, New York, Michigan, and Washington, D. C. We always stopped at interesting places: many national parks and places of historical interest.

Dad was very safety conscious. He bought large cars because they were safer, and had seat belts installed, long before they were required by law, and insisted that we wear them.

Traveling cross-country by car was different in those days. There were few interstate highways and no GPS, so we relied on paper maps, road atlases, and the AAA guidebook for motels. Cars were also less reliable, and having one's car break down could leave the traveler stranded and forced to rely on strangers to stop and help. On one such occasion in the fifties, Dad stopped to help an African-American woman with her children, and got her car running again, after she had been waiting for hours for someone to stop and help.

One winter we were driving west before dawn across the flat north Texas cotton fields. Dad offered a nickel to the first one who saw the sun come up behind us, and suggested that we watch the tops of the telephone poles for the first rays. We later realized that this was mostly a ruse to keep us quiet for a few minutes.

Because of our travels, my brothers and I developed a broader view of the world than our peers in school. We were flexible, adaptable, and able to approach problems from multiple viewpoints. And this early travel made it easy for us to travel and live abroad later on.

2. Athletics

Dad placed a high value on keeping fit, especially after reading Ken Cooper's book on aerobics. Our parents stressed that we should find a form of exercise that we could continue for life, such as swimming or tennis.

Mom and Dad took group tennis lessons when we were small. When we children were old enough, we, too, took lessons, and we sometimes played doubles as a family. Because of these early lessons, I ended up on my high school and college tennis teams.

During our years in middle school, Dad decided we should join a swim team. Not only would it build our adolescent muscles and have a permanent beneficial effect on our physiques, but it would also keep us too tired to get into trouble. We all swam competitively for a while, and we still swim for exercise.

We have fond memories of spending time at the pools in Lausanne and Seattle, camping and hiking in the Sierras and Cascades, sailing our small sailboat (a Penguin) in Lake Austin, and skiing at Monarch Pass in Colorado.

Months ahead of our ski trips, we would gather in the living room after dinner for calisthenics. Dad would count for the various exercises: deep knee bends, rising on toes, toe touches, sit-ups, running in place, and pushups. Dad's plan was to add one more pushup every day, although he eventually found that he plateaued at about 30.

Dad loved the outdoors, and we made many camping and hiking trips. We had good hiking boots and down sleeping bags from REI long before such gear was fashionable.

Dad went to climbing school and learned how to use an ice axe and crampons. With these skills, he climbed Mt. Rainier. When we children ranged in age from 5 to 8, as a family we climbed Mt. Whitney. We also climbed Mts. San Jacinto, Lassen, and San Gorgonio.

In Switzerland, we hiked up the Gornergrat from Zermatt, which was memorable because Mom and Dad forgot that elevations on European topographical maps were measured in meters rather than feet.

For 56 years in Austin, Dad spent every lunchtime at the gym on the University of Texas campus, where he would run, swim, and lift weights. He noted his daily exercise and weight on a tiny space on a 3×5 card. Afterwards he returned to his office for a can of V-8 juice, his favorite way to ingest vegetables.

3. Music

Classical music was very close to Dad's heart, and he had a fine stereo system. His record collection was enormous, eventually reaching 44 linear feet of classical LPs before he began replacing them with CDs. He always put on music for our family meals.

Dad was an excellent clarinetist and during his youth played clarinet in the city orchestra and saxophone in dance bands. He continued to play chamber music throughout his life. He would practice his clarinet after we went to bed in the evenings, often to a Music-Minus-One record, with the sound of the whole orchestra or chamber ensemble playing with him.

Dad made sure we three children took music lessons. For David, it was the oboe, and for Elliott, the cello, which became his career. I took piano lessons. During our required hour of music practice after dinner, I played the piano in the living room while my brothers simultaneously practiced in their rooms. Remarkably, Dad was able to supervise our practice from his study. Amid the cacophony of notes, with his perfect pitch he could hear a mistake and would yell, "Margaret, E-flat!"

In recent years my brother David admitted that sometimes he wasn't practicing the oboe at all. Instead he was playing a tape-recording of himself, while he relaxed on his bed reading books. My parents finally let David stop taking lessons because, in their words, he didn't seem to be making progress.

4. Dad's Projects

In the early 1960s, Dad began work on his approximation theory book, which Mom typed on a typewriter modified to have mathematical symbols. This became his classic 1966 Introduction to Approximation Theory, which is still in print. He continued writing textbooks, by turning his course notes into finished manuscripts with exercises, throughout his career.

Dad enjoyed building electronic gear from Heathkit build-it-yourself kits. This produced his first stereo equipment and a shortwave radio that sat on a table in the living room.

FIGURE 2. Portrait of Ward Cheney by son-in-law, artist Kevin Aldrich, 2013

Dad showed my brother Elliott how to solder and helped him put together electrical kits. He also taught him the basics of working on cars: how to set points, check timing, and adjust valves.

In some of our houses, Dad and Mom embarked on masonry projects, such as laying bricks for a patio or paving to control water runoff. While our parents did the skilled work of mortaring and laying the bricks, we children had the task of bringing them the bricks from a stack in the driveway. Invariably there were spiders and insects on the bricks, and we learned always to wear gloves.

Dad had a longstanding interest in photography, and many photos from our hiking trips even show him with a light meter hanging around his neck. Thanks to this hobby, our childhood is richly recorded in color slides. When we were in high school, he set up a darkroom in the house, and developed and printed his own photographs.

5. Household Routine

Dad was the family banker and kept accounts for us children on 3×5 cards. We got a weekly allowance and were also paid hourly for required Saturday housework. Mom and Dad would assign tasks: vacuuming, cleaning bathrooms, washing the car.

FIGURE 3. Ward Cheney in his home office, late 1970s

Dad worked in his study until after our bedtime. Sometimes we were awake long enough to hear Mom and Dad having a bedtime snack, over which they would discuss departmental politics and us children. Later in life, Dad's bedtime snack (consumed around 10pm) consisted of a baloney sandwich, Fritos corn chips, Guinness Stout, and, as a finale, a glass of port and a handful of mixed nuts. He was, however, careful never to gain weight.

If we complained to Dad that we didn't have enough time, he would ask, "OK, you spend 8 hours sleeping, 7 hours in school, and one hour practicing your music. That still leaves 8 hours. What are you doing with those 8 hours?"

In the late 1960s, Dad grew a beard and changed his business attire from white shirt, tie, and tailored slacks to brown corduroy pants, blue shirt, and wire-rimmed glasses. (He explained that the brown pants didn't show dirt splashed up by his bicycle when he commuted to campus.) He always carried his keys on a clip that attached to a leather tab that hung from his belt, so the keys were always in his right back pocket. He never, ever misplaced his keys or wallet. He never misplaced a cell phone because he never owned one.

6. Dads influence on my career in mathematics

Dad didn't explicitly encourage us to do science or mathematics, and I got the distinct impression that he didn't necessarily recommend going into mathematics, although it was fine if we really wanted to. He did want us to be good musicians, and may have been disappointed that only my brother became a professional musician.

He did give me a book of mathematical science fiction stories (*Fantasia Mathematica*, ed. Clifton Fadiman, Simon & Schuster, 1958) that included a discussion of the Hilbert Hotel and stories about the 4th dimension, that I enjoyed very much.

I hardly ever went to him for help with math problems: I found it very discouraging that something I was struggling with was so easy for him. I would sometimes

FIGURE 4. Margaret Cheney and Ward Cheney at the International Conference on Approximation Theory, College Station, January 1995

hear him talking on the phone about L^p spaces, and it seemed like a secret language that I wished I knew.

During one of my summers in high school, he arranged for me to help him write and run some computer programs. He gave me the equations, and I wrote up a little Fortran program, punched cards for it, and ran them at the campus computing center for him.

When I went off to college, it turned out that he was acquainted with one of the professors in the math department, namely Sam Goldberg, so I picked Dr. Goldberg to be my academic advisor.

In my senior year of college, when I decided I wanted to go to grad school in mathematics, Dad was very helpful in explaining that my poor performance on the Putnam exam did not necessarily correlate at all with future success as a creative mathematician. As I launched my career, he took on the role of mentor, and it was helpful to be in frequent correspondence with him.

Some mathematicians were especially nice to me because they knew and liked him. For example, Gene Golub re-introduced himself to me, reminding me that he had had dinner with our family when I was a teenager.

At conferences, sometimes people would come up to me and ask about my numerical analysis book. I would explain that they had the wrong Cheney, but I'm sure the confusion didn't hurt my career.

Dad and I attended some conferences together, for example the 1997 SIAM meeting at Stanford. There we were invited to a garden party at Gene Golub's house. Donald Knuth looked at our name tags, Margaret Cheney (RPI) and Ward Cheney (U. Texas), and commented "That's a long commute!

7. Dad's Values

Dad and Mom believed that saving for their children's education was a "sacred duty" – Dad's words literally. They were supportive of all levels of our education. They bought houses in the best school districts. When we were little, Dad drilled us with arithmetic flash cards, timing us to get our speed up.

Dad subscribed to the theory that there's no such thing as too many books. He had an enormous library, and books were frequent gifts within the family.

Dad's mother was widowed in 1959 and lived nearly four more decades, to age 97. Dad was a devoted son: he sent gifts, visited her twice a year in Pennsylvania, and called her weekly from Austin. If he was overseas, he wrote letters to her weekly. He said the way to be sure a task gets done is to schedule it, and he scheduled his letter writing and phone calls.

Dad had an excellent sense of humor. He had a large collection of humor books, and he especially enjoyed the old films of Charlie Chaplin, Harold Lloyd and Buster Keaton. On the other hand, he refused to watch movies that depicted graphic violence. When video recording became possible, he would tape good movies appearing on TV. He explained that he didn't have to watch TV because he had a machine to do it for him.

Dad is primarily responsible for helping us to develop discipline. He set an example by his consistent work habits. When we balked at practicing our music lessons and wanted to quit, he said, "You don't want to be a quitter, do you?" We learned that continued work brought results.

Dad always conducted himself with honesty and integrity, and was upset when others didn't. He defended personal liberties and supported policies that help the disadvantaged and the environment.

Dad set an excellent example for us, in terms of working hard, staying fit and healthy, and also being unassuming, kind, and fair. He was also fun to be around, introducing interesting topics of conversation and making frequent jokes.

We all miss him, but his influence is a continuing part of our lives.

List of Doctoral Students of Ward Cheney

1. Barry William Boehm (1964)
2. Daniel Eliot Wulbert (1966)
3. Yasuhiko Ikebe (1966)
4. Johnnie Warren Baker (1968)
5. Robert William Vargas (1968)
6. Bill Delano Anderson (1970)
7. Kenneth Hugh Price (1970)
8. Theodore Albert Kilgore (1974)
9. Joonsook Kang (1989)
10. Xingping Sun (1990)
11. Valdir Menegatto (1992)
12. Kuei-Fang Chang (1993)
13. Debao Chen (1994)
14. Sung Sik Yun (1995)
15. Nahmwoo Hahm (1996)

16. Zuoshun Zhang (2000)
17. Mihaela Dobre Pal (2003)

List of Publications of Ward Cheney

Papers

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