



*J. C. Tiers*

# OLGIERD C. ZIENKIEWICZ

1921–2009

Elected in 1981

*“For outstanding contributions to development of finite element method theory and dissemination of knowledge concerning its application to engineering practice.”*

BY ROBERT L. TAYLOR

In May 2011, I attended the 19th International Conference on Computer Methods in Mechanics held in Warsaw, Poland. As I sat in a main lecture hall of the Warsaw University of Technology for the opening session, I could not help but recall my good friend Olgierd Cecil Zienkiewicz, who died on January 2, 2009, in Swansea, Wales, after a brief illness. In the summer of 1939, Olek (as his friends knew him) was in Warsaw preparing to take the entrance examination to enter the Technical University to study civil engineering. The events of September 1939 changed the course of his career and undoubtedly that of the field of computational mechanics.

At the time of his death, Olek was professor emeritus and director of the Institute for Numerical Methods in Engineering at the University of Wales, Swansea, and held the United Nations Educational, Scientific and Cultural Organization chair of numerical methods in engineering at the Universitat Politècnica de Catalunya in Barcelona, Spain. During his long career he was a great engineer in the construction of hydroelectric projects, author of many books and technical articles, cofounder of technical journals, and a leader in the field of civil engineering. He was also an avid sailor, enjoyed snorkeling, and was an adventurous gourmet.

Olek was born on May 18, 1921, in Caterham, Surrey, England, the son of a Polish father, Kasimierz, and an English mother, Edith. At the age of 2, his family relocated to Poland. During the next few years the family moved several times, which often interrupted his studies. Thus, at an early age Olek developed the ability to learn new subjects from reading on his own and personal tutors. He had a phenomenal memory and could, in late life, clearly recall poems of the Iliad learned from his Latin tutor, sing the Polish songs of Wladyslaw Szpilman, and recall salient points from any of his publications.

In the early 1930s the family settled in Katowice, where his father had attained a position as a judge in the regional court. To prepare for university, Olek was sent to a boarding school in Rydzyna, where he studied science subjects, literature, and learned the art of boat building. In June 1939, he completed his high school studies in the fields of mathematics, descriptive geometry, and physics. During the summer of 1939 he was able to complete a sailboat he had started in Rydzyna and learned the art of sailing. His love of sailing instilled in him a desire to study naval architecture at university. However, none of the three polytechnic universities in Poland offered the subject. Thus, Olek chose civil engineering and was in Warsaw preparing for entrance exams to the university when the Second World War began. In early December his father was able to obtain visas for the family to go to Italy. Shortly thereafter they secured visas to enter France, where the Polish government in exile was situated. They remained in France until mid-1940, when France fell to the German advance and they finally left for England. By the summer of 1940 the family was settled in London, and Olek attained a scholarship as a Polish student to attend Imperial College, where he received his bachelor of science degree in 1943. He continued with postgraduate studies and completed his doctoral thesis in mid-1945 with Professor Richard Southwell (later Sir Richard) performing research with "relaxation methods" to study the uplift pressures on dams.

In August 1945 he secured employment with the firm of Sir William Halcrows & Partners as an engineer in charge

of a survey party for the design of hydroelectric schemes in Scotland. For the next few years he worked on the design and construction of the hydroelectric schemes at Glen Affric and Mullardoch. In 1949 he accepted his first academic appointment as a lecturer at Edinburgh University.

During his period in Edinburgh, Olek continued to work on problems related to hydraulic and structural problems encountered in hydroelectric projects. His studies were both experimental and analytical. In 1951 he met Helen Fleming at a dance. After a one-year courtship they were married in December 1952. In the second year of their marriage, Olek and Helen welcomed their first son, Andrew. A second son, David, was born in 1955.

In January 1958 the family moved to the United States, where Olek had accepted an offer as a visiting professor at Northwestern University. Then in March they welcomed the arrival of their daughter, Krysia. Olek's research at Northwestern focused on structural problems, many still related to the behavior of dams. He continued to apply relaxation solution methods to finite difference equations throughout this period. At this time he also heard about what was to become known as the finite element method from Professor Ray Clough (NAE member) of the University of California, Berkeley. At the time Olek believed finite difference methods could solve all elasticity problems equally well, but that finite element methods offered a way to solve shell problems associated with arch dams if appropriate bending elements could be developed.

In 1961, Olek was appointed chair of the civil engineering department at the University of Wales, Swansea. At the time of his appointment the civil engineering department consisted of five faculty members. During the next few years Olek appointed several additional staff who would later become well known to the computational mechanics community. It was in Swansea that Olek started research on finite element methods. By 1962 he and his students had succeeded in devising a thin plate element of rectangular form that converged for known plate solutions. In 1965, working with Bruce Irons, who was then

an engineer at Rolls-Royce, Olek produced a triangular plate-bending element that was fully conforming. A little later he was successful in bringing Irons to Swansea as a lecturer. This was a fortuitous appointment as Bruce was aware of much work being performed in the aeronautics industry, including that of Ian Taig on direct construction of quadrilateral elements. At Swansea this evolved into the family of isoparametric elements that were successful in generalizing element forms for use in two- and three-dimensional problems of elasticity and of other subjects. The introduction of isoparametric elements was a major advancement to the finite element method and greatly simplified the development of computer software.

Olek devoted a significant portion of his activities to the solution of real engineering problems. One of the first dams he analyzed was the Clywedog Dam in Wales. According to Olek, this was the first time that finite elements had been used as part of the design of a new dam. He also traveled extensively to attend conferences and give lectures at universities and industrial centers. Through these he quickly became known as the "Ambassador of Finite Elements"!

Olek wrote the first book devoted to the finite element method. *The Finite Element Method in Structural and Continuum Mechanics*, published by McGraw-Hill Publishing Company Limited, London, 1967, consisted of some 270 pages. The book was an immediate success and firmly established Olek worldwide as a leader in finite element theory and practice. The book has appeared in five subsequent editions, with the current edition, published in 2005, consisting of three volumes numbering nearly 1,800 pages.

By the late 1960s Olek realized that publication of numerical finite element research required a new outlet, since the available journals in mechanics were more interested in theory than solution methods. Together with Professor Richard H. Gallagher (deceased NAE member) as coeditor, he established the *International Journal for Numerical Methods in Engineering*, which was first published quarterly in 1969. The journal grew rapidly over the years to its present 48 issues per year. From his travels around the world, Olek also recognized

a need for an international organization devoted to numerical methods. Through his efforts the International Association of Computational Mechanics was founded in 1986 and he served as its first president for four years.

During the next 25 years, Olek and his colleagues and students developed and applied finite element methods to solve a wide range of applications—from problems in solid mechanics to problems in fluid dynamics to problems in electromagnetism. The topics Olek addressed during his career resulted in almost 600 papers and 13 books.

After a career spanning five decades, Olek retired in 1988 as head of civil engineering at Swansea. Following this retirement, he served as director of the Institute for Numerical Methods in Engineering at Swansea, where he continued his research and supervision of doctoral students.

Through his research and associations with scholars throughout the world, Olek achieved an international reputation as a leader in the development of finite element methods. In recognition of his achievements, he was elected a fellow of both the Royal Society in Great Britain and the Royal Academy of Engineering in 1979. Shortly after his retirement, Queen Elizabeth II awarded him the title of Commander of the British Empire in recognition of his lifetime accomplishments. In 1981, Olek was elected as a foreign member of the National Academy of Engineering. He was also a foreign member of the Accademia Nazionale dei Lincei (Rome), the Chinese Academy of Sciences, and the Polish Academy of Sciences. In 2005, he received the Prince Philip Medal of the Royal Academy of Engineering.

The adage that “behind every great man is a great woman” was especially true for Olek. His wife Helen was his teammate and acted as hostess to the many students, colleagues, and friends who visited their home in Swansea. She was a loyal partner throughout all of his activities.

Olek leaves a legacy in the form of his books and writings as well as in the many students and collaborators who benefited from his advice and tutoring. He was indeed a distinguished scholar and a good friend to many. He is greatly missed but not

forgotten! He is survived by his wife, Helen, and their children, David and Krysia. His firstborn son, Andy, died a year after his father. Olek is also survived by his grandchildren—Ami, Adam, Jaimie, and Kate. Krysia's son Jon tragically died at the age of 11 from leukemia.

Andrew wrote in his eulogy for his father the following:

My Dad was a sailor, determined to enjoy himself. Some of his happiest photos are in the middle of Swansea Bay. Many sailed with him, or learned how to sail with him, or just got roped into boat maintenance. He didn't usually plan a sail, but was happy to see which way the wind was blowing and what looked interesting.

As children growing up, we all got used to wandering day trips or holidays, full of diversions to whatever looked interesting. Long walks on Gower, which he loved and kept him anchored in Swansea. Climbing up sea cliffs, often with no choice as the tide rose behind us. Long snorkeling adventures in the Mediterranean, returning with edible fish or an octopus or just something with poisonous spines. Sailing across the channel to France and working out the best use of custom allowances.

While traveling he would spot a dam or bridge under construction, or recently collapsed, and then to his children's cringing embarrassment, march up to the security gate and never fail to talk his way in. And we would see wonderful things, huge civil engineering projects, research labs, inside other people's houses. He knew that people like to talk about what they do and he let them know that he wanted to hear about it.

Intellectually, any question could start a discussion, sometimes a lecture, on science, maps, history, math, religion. If he did not know, then we would be sent to get the big books and do research. I remember him ringing up a priest in the middle of the evening because we could not figure out the ethical point of a parable.

Gastronomically, he would try anything. And we got the benefit of that, learning to love food from France, Yugoslavia and Poland and what to do with anything found in the sea.

Most of all he showed us there was a big world out there. A world, most of which he visited, some of which he showed us and an awful lot of which passed through our living room in the form of his friends and colleagues. He enjoyed sailing with all of them.



