Charles William (Bill) Trowbridge

Bill Trowbridge was born in Hampshire in 1930 and educated fist at Brockhenhurst Community County High School, and then at HMS Conway to train as an officer in the Merchant Navy. After nearly 10 years as a navigating officer, he decided to instead pursue a career in science, and joined AERE Harwell in 1957. He joined the team involved in building particle accelerators for nuclear structure physics, whilst also studying part time for a degree in theoretical physics from University of London. He later started to specialise in the application of computers to the solution of practical electromagnetic field problems, and transferred to the Rutherford Laboratory in 1964, and subsequently became the leader of a newly formed Computing Applications group.

Although some CEM products already existed, mainly developed by Research Institutes, and running on mainframe computers, it was not until the period 1970-72 that the group developed the GFUN program that utilised a storage tube display, which allowed interactive use of the software. By 1972 they had also extended it to solve 3D simulations – one of the first interactive 3D CAD software tools.

During his period at Rutherford Laboratory (later to become Rutherford Appleton Laboratory, RAL), Bill was asked to develop various initiatives, mainly with a focus to determine the software requirements for University research. This led to the establishment of a series of Special Interest Groups, including one on Electromagnetics (SIGEM). A number of prestigious University and Industrial researchers were involved in this group over the years.

Cris Emson recalls: "I joined Bill's group at RAL in 1982, and recall it being a very exciting period in the area of CEM. We were actively involved in a number of Conferences, and had established a series of Eddy Current Workshops to allow informal discussions on the best way forward to handle 3D eddy current and time varying analysis."

In 1984, it became apparent that computer simulation software was the way forward, and that it had to be regarded in a similar way to hardware – it required development and support. Although the software was being marketed globally through a company COMPEDA, when that company was sold to PRIME computers it became obvious that software was not in their interest. Consequently, Bill co-founded the company Vector Fields, with Bill as its Chairman, specifically to develop and market software for CEM.

The company started at a very modest level, with only 2 full-time employees – co-founder John Simkin (RAL), along with Employee #1, Dinah Trowbridge (Bill's daughter), working from an office rented from Oxford Instruments. It was just a few years later that the company had been expanded to include Bill himself, plus John Whitney as the third Director (responsible for Sales & Marketing), Chris Riley (who had worked with John Whitney at COMPEDA), Clive Bryant (formerly Imperial College working with Ernie Freeman), plus ex-RAL employees Chris Biddlecombe, Bryan Colyer and Cris Emson. By this time the company had moved to new offices near Oxford, which was formally opened by Prof Zienkiewicz FRS in 1987.

Following further developments in the software suite, to include ELEKTRA for 3D eddy current analysis, the level of scientific work was finally recognised in 1992 when Vector Fields received the Queen's Award for Technological Achievement, and Bill received the IEE (now IET) Achievement

Award in Science, Education and Technology. In the 1993 New Year Honours he was appointed by HM Queen Elizabeth II an Officer of the British Empire (OBE) for services to science and exports.

Bill has received a number of awards over the years, ranging from an IEE Maxwell Premium for Best Paper (describing the Total and Reduced Scalar Potential methodology), Visiting Professorships, a foreign member of the Royal Netherlands Academy of Arts and Sciences, the IEE Innovation Medal, and an Honorary Doctorate at Graz University. The UK Magnetic Society had particular pleasure in presenting to Bill their Lifetime Achievement Award early 2018 for his contribution to Computational Electromagnetics.

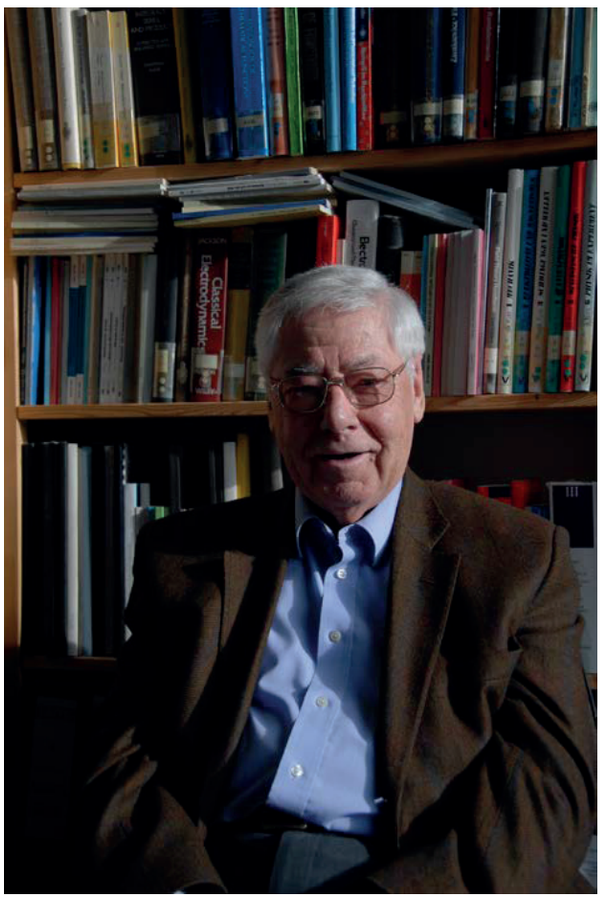
Although very involved in technical developments himself, probably the major contribution that Bill made to the field of CEM was the inspiration and leadership he showed to others. Our community owes Bill a huge debt of gratitude for all the work, enthusiasm and guidance he put into making us what we are today.

"I had the privilege to have worked with Bill since 1979, and I consider him to have been an outstanding mentor and friend." – Cris Emson

Of course, Bill also had very wide interests and knowledge outside CEM as well, which he was delighted to share with many of his friends. One of the overriding passions was for opera – hence, the names of the Vector Fields' products

"*Bill and I had a wonderful evening at the Metropolitan Opera watching The Damnation of Faust. The trouble was, we had only just arrived in New York from London – such was Bill's enthusiasm" – Chris Riley*

Cris Emson and Chris Riley



Bill Trowbridge

Who was Bill Trowbridge? A master mariner, a high energy physicist, a trailblazer in computational electromagnetics, an entrepreneur, or someone dedicated to his family? The answer is that he was all of these and more. This article is intended to explore Bill's impact on the computational electromagnetics (CEM) community and through that on society as a whole but it is only part of the story. Much of the rest can be found in other articles in this issue of the newsletter and in Bill's own autobiography.

Starting at the beginning, in the early 1970's, computational electromagnetics was in its infancy. The design processes for electromagnetic devices had changed little for most of the twentieth century but the arrival of digital computers had opened up the possibility of the relatively fast solution of the equations developed by Maxwell for parts of an electromagnetic device but the goal of generating a solution for the whole device seemed elusive with the partially analytical methods in existence. However, in the 1960's, numerical approaches for the solution of the field equations were being considered and key papers on the use of finite differences, finite elements and integral approaches had been published, but the computational power needed to truly leverage these methodologies had not yet developed. Bill Trowbridge arrived in this environment in 1971 at a time when development of both computational resources and numerical methods were changing at a rapid pace. The requirements of the high energy physics community in terms of accelerators, and the magnets needed to control the beams, became apparent and the existing design tools were not sufficient to develop devices with the necessary characterstics. Bill began at the Rutherford Laboratories and gradually built a world-class team developing some of the first computational electromagnetics codes. His association with the national research labs in ths United States both accelerated the development and created a community of users across two continents. This led to the creation of the GFUN User Group Meetings – possibly the first conferences dedicated to computational electromagnetism. These meetings morphed, over a period of about 20 years, into what is now the well-established IEEE Conference on the Computation of Electromagnetic Fields (CEFC).

At around the same time in the early 1970's, I had completed a Ph.D. working with Prof. Ernie Freeman on Linear Motors and, because of the limitations of simulation, we had worked on developing scale models which could provide the experimental data needed to design large devices, but had several limitations. We needed simulation tools! After my Ph.D., I moved to Imperial College in London to work with Dr. John Carpenter on electromagnetic field analysis and the design of low frequency systems. The intention was to develop the simulation systems which could replace the experimental models. This brought me into contact with Bill who was working with John to look at the needs of University researchers and the developing the basic simulation work that was going on. It was not long before the two groups were talking about computational electromagnetics more seriously. The development of the early version of the T-Ω methodology for 3D solutions by John occurred during this collaboration.

During the early 1970's, Bill had constructed a community of researchers from around the world in industry, government laboratories and academia who were involved in electromagnetic systems and saw the potential of computer based simulation systems. By 1976, the links were significant enough that a new international conference was proposed to share the work going on – this was the first COMPUMAG conference and the list of attendees includes many of those who might be considered as the pioneers of the computational tools that we use today and several went on to establish commercial organizations in the area. Following the success of the first conference, a second was organized two years later in Grenoble by Jean-Claude Sabonnadiere and

the committee was chaired by Bill. By this point, the conference had become established and, with Bill as the early driving force, the series has run in alternate years since that time and has visited many countries and continents, encouraging the advancement of computational electromagnetics research and development everywhere it has been hosted.

In 1991, at the COMPUMAG conference in Italy the International Steering Committee discussed the concept of creating an umbrella organization for computational electromagnetics activities around the world. The goal was to create a structure that would provide a forum for collaborative work and discussions on a continual basis, rather than just every two years. It would oversee the formal conferences and the TEAM workshops as well as supporting smaller, satellite conferences held locally around the world. By 1994, thanks to Bill's energy and commitment to the idea, the International Compumag Society (ICS) had been created with Bill as its first President and Jan Sykulski as its first (and to date, only) Secretary. In 2001, Bill resigned as president of the ICS – having completed the job of seeing it through its early growth phases - and was appointed as the Honorary President, a position he held until his death.

It is interesting to consider Bill's involvement with the development of computational electromagnetics and his strong encouragement of everyone involved in the international research efforts that took place and the effect of this on society. In parallel with the development of the computational tools there has been an explosion in the use of low frequency electromagnetics devices. In the late 1960's and early 1970's, the applications of such devices were growing but limited. There was much talk of the uses in high speed transportation (mainly rail), in large physics experiments and in some domestic equipment and tools – an electric drill or a hair drier was an expensive purchase. The major application areas were still heavily in industrial machinery. Through the 1970's and the end of the twentieth century, there was an dramatic increase in the use of electromechanical systems. This has occurred because of improved manufacturing capabilities and the presence of advanced design software that allows companies to produce designs faster, optimize them and reduce the material usage. All this reduces costs and with this reduction, devices started to appear everywhere. You cannot walk into a modern home / kitchen / workshop / garage / garden / play area, without encountering dozens of these devices embedded in appliances; a modern car could not function without the hundreds of devices engaged in everthing from improving the efficiency of internal combustion engines, or replacing them, to automatically controlling the internal climate and seat positions and even the structure. One drill is now hardly sufficient for the home handyman and industrial automation plus transportation would be impossible without huge numbers of electric motors/actuators. These changes, which society has hardly stopped to notice, have come partly as a result of the amazing simulation capabilities that exist today and these, in turn, were inspired by the community that Bill was seminally instrumental in creating. The work in government laboratories, academia and industry to develop tools has been largely driven by the original group that met in 1976 under Bill's leadership.

As an individual, my career choices and research work were heavily influenced by Bill. He acted as a mentor, friend and supporter. He was always available to discuss anything from his favourite whisky to the latest ideas in CEM.

We shall miss him.

David Lowther