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Introduction

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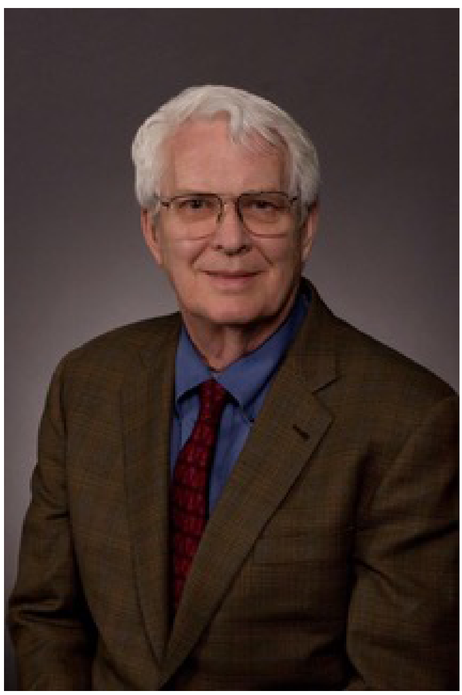
We dedicate this special issue, "Crossing Computing Frontiers" to Dr Edward H. Allen (Ned for his family, friends and collaborators)—a scientist, entrepreneur, brilliant innovator, and, for many worldwide, a good friend—on the occasion of his retirement as Lockheed Martin's Chief Scientist (2020) and his 80th birthday (in early 2023).



Ned is an American expert in the mathematical modelling of complex systems, a Fellow of the Foreign Policy Research Institute advising the U.S. National Security Council on international technology policy and a Fellow of the AIAA. He is an adjunct professor at the University of Maryland and the University of Queensland and was, until his retirement, Lockheed Martin's Chief Scientist and Corporate Senior Fellow (2012-202)—the position from which Ned formed collaborative relationships with the editors and contributors to this issue. Ned's expansive scientific vision during his years at Lockheed Martin was not only frequently unconventional, but often completely alien to the corporate business structure within which he was embedded. The research he supported, and the manner in which he financed it, was completely novel in the beginning and required that he educate business, financial, and legal leadership—none of whom was fully aware of the potential latent in the agreements and obligations the corporation already held. It is a measure of Ned's vision and persistence that, as of his retirement, the Lockheed Martin leadership considers the research and business strategies that he pioneered (against some considerable objection at first) to be self-evident, if not completely obvious. In his spare time, Ned provided the legal staff yet more intellectual stimulation by authoring more than thirty patents

Inspired by Eugene Wigner's 1960 paper on the "Unreasonable effectiveness of mathematics in the physical sciences" and Richard Feynman's 1982 seminal follow-on, "Simulating physics with computers", he founded Lockheed Martin's program in quantum information science and computing nearly 20 years ago. He identified crucial and exciting problems and with limited funding supported researchers around the world to explore them—and in doing so planted a seed from which has sprouted a surprisingly large proportion of the quantum computing work now occurring worldwide.

One could be tempted to think that Ned, in good health, is enjoying a comfortable new life of leisure But nothing is further from reality: Ned is fully immersed in several new research projects in his favourite areas (which include, of course, complex systems and quantum information), involving old and new collaborators scattered across the world, working long and fruitful hours. They include, of course, the editors of this special issue

This special issue includes a) an idiosyncratic retrospective view of Ned's own life, "Skunks' Chief Scientist"; b) a non-technical and personal perspective on the history of the evolution of quantum computing, "Ned Allen: The Man Who Took Quantum Computing into The Real World" by D. Lidar; and c) five technical articles in areas related to or inspired by Ned's research activity.

The article "A Path to Enabling a Wider use of Controlled-accuracy 3D CFD in Industry and Academia" by W. G. Habashi a) identifies impediments to the use of advanced 3D CFD b) demystifies them, and c) proposes practical approaches to enable small and medium-sized enterprises to take advantage of advances in algorithmic and computational power without maintaining an onerous infrastructure. Examples from aerodynamics spanning low subsonic speeds up to hypersonics are discussed.

The paper “Cascading of Nanomechanical Resonator Logic”, by X. Jin, C. G. Baker, E. Romero, N. P. Mauranyapin, T. M. F. Hirsch, W. P. Bowen and G. I. Harris proves that cascading nanomechanical logic gates, where the output of one gate is fed into the input of another, is a complex problem due to the transient dynamics of the collective system; a way to circumvent it is by carefully initialising the system before computation. These salient features are illustrated through the modelled dynamics of two cascaded nanomechanical NAND gates.

The article “An Overview: Steady-State Quantum Entanglement via Reservoir Engineering”, by A. Pedram and Ö. Müstecaplıoğlu presents a short overview of quantum entanglement generation and preservation in a steady state. The steady-state entanglement is essential for existing quantum technologies, quantum computation, communication, sensing, and simulation. Examples of their use in emerging and future quantum technology applications, particularly quantum heat engines and quantum energy processing, are proposed.

The article “Comments on Quantum Computing in Nuclear Physics” by P. D. Stevenson reviews recent research on quantum computing applications for calculations and simulation of nuclear physics. The quantum simulation of systems of interacting fermions and nuclei bears much similarity to the quantum computation of chemical systems, whose studies are relatively more advanced. Hence techniques from the quantum chemistry literature may be readily adopted. Some ways in which nuclei differ from other many-body systems, such as the strong non-perturbative interaction, are highlighted, and a selection of existing results are discussed, covering nuclear structure and reactions.

The paper “An Equivalent QUBO Model to the Minimum Multi-Way Cut Problem”, by S. Heidari, M. J. Dinneen and P. Delmas presents a) an efficient QUBO solution for the minimum multi-way cut problem and b) examples run on a D-Wave hybrid quantum-classical solver.