Turing's Cathedral: The Origins of the Digital Universe FREE

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Physics Today **65** (10), 56 (2012);
https://doi.org/10.1063/PT.3.1752

Tales of modern computing pioneers

Turing's Cathedral
The Origins of the Digital Universe

George Dyson
Pantheon Books, New York, 2012.
$29.95 (432 pp.).
ISBN 978-0-375-42277-5

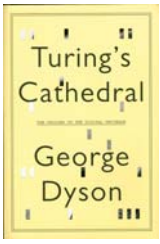
Reviewed by Francis Sullivan

George Dyson has accomplished something that many would consider almost impossible. With *Turing's Cathedral: The Origins of the Digital Universe*, he has written an engaging and authoritative history of the complex interplay between the creation of thermonuclear weapons and the creation of the earliest stored-program computers, particularly the MANIAC machine built at the Institute for Advanced Study in Princeton, New Jersey.

Interwoven through Dyson's rendition of the saga at the IAS is an excellent start on a biography of John von Neumann, whose work was vital to the conception of the MANIAC, along with biographical sketches of most of the major players in the drama. Dyson manages to tell an objective and balanced story. He shows the not-so-saintly side of some revered characters and reveals the deep commitment of other characters—commonly considered "true villains" and dangerously ambitious—to ideas they perceived as noble.

The book is organized into many short chapters, each given an interesting title. For example, chapter seven is called "6J6" after the name of the main vacuum tube used in MANIAC. That chapter depicts, in all its entertaining drama, the culture conflict between engineers and pure mathematicians cohabiting at the IAS six decades ago. In addition, the essential computer engineering of Julian Bigelow finally receives the attention it has long deserved.

How the MANIAC project came to be centered at the IAS and how those working there solved critical problems in nuclear-weapons design before others is a fascinating tale in itself. Although MANIAC was applied to many different problems, its main purpose was the modeling of thermonuclear weapons. And the most important algorithmic tools then were the Monte Carlo methods. Interestingly, von Neumann met his wife, Klara, in Monte Carlo (though by some accounts, they had actually met earlier in Budapest), and Klara did much of the coding for the early weapons work at the IAS. Her work there was a natural extension of earlier studies in population genetics.



According to Dyson, tying the MANIAC project to weapons work and centering it in Princeton was a consequence of the global political situation at the time and of the personal histories of members of a small group of brilliant and strong-willed scientists and engineers. A brief retelling of the Teller–Ulam design and its crucial role in weapons development is included in Dyson's narrative. From reading *Turing's Cathedral*, one begins to understand how, among other things, the early lives of both von Neumann and Edward Teller affected their later attitudes about nuclear weapons.

The book's title is drawn from Alan Turing's notion of a universal computing machine. Turing showed that with a limited set of instructions one can, in principle, evaluate any computable function. More important, he introduced the idea of a universal machine that takes as input a description of a machine plus input for that machine. In other words, it treats the input machine as data and as a program that operates on other data.

Turing's abstract machine, like almost every major discovery, was anticipated earlier—in this case by Emil Post. And Alonzo Church certainly had proved independently that the decision problem was not solvable. The work of Kurt Gödel was another fundamental precondition for the invention of stored-program machines. The idea of converting logical propositions to numbers was Gödel's. One could then reason about such converted propositions using other propositions. That trick pointed the way to universal machines. In addition, it was Gödel's deep understanding of the importance of propositions saying something about themselves that turned a mere paradox into a tool for investigating the nature of proof and computation.

One theme running through the story is the aspect of tragedy in the lives of some of the early creators of modern computing. In many respects, Gödel was a tragic figure, and his death, in the final analysis, was a result of his damaged mental state; von Neumann's last days were filled with physical and emotional suffering; and Teller, who had a long life, is said to have felt ostracized by his friends and colleagues as a result of his behavior during the debate over J. Robert Oppenheimer's security clearance. And, as has been documented many times in writing, on stage, and in film, Turing's death, which was ruled a suicide—and his life, too—was tragic.

Turing's Cathedral tells an important story, enlivened with many almost-forgotten but fascinating details. One ends up feeling that someone must have lent Dyson the keys to the attic of the IAS.

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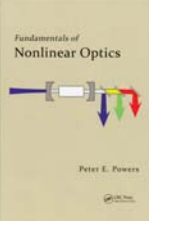
Fundamentals of Nonlinear Optics

Peter E. Powers
CRC Press/Taylor & Francis, Boca Raton, FL, 2011. $79.95 (311 pp.).
ISBN 978-1-4200-9351-3

Nonlinear optics is usually considered a difficult subject because it relies heavily on electromagnetic theory, quantum mechanics, and advanced mathematical concepts from vector analysis, tensor algebra, symmetry, and group theory. In *Fundamentals of Nonlinear Optics*, Peter Powers's rigorous but simple description of a difficult field keeps the reader's attention throughout.



Fundamentals of Nonlinear Optics begins with a short introduction to the subject's history and its foundational concepts. It then provides a primer on key linear optical phenomena, such as the propagation of electromagnetic waves in anisotropic media, birefringence, dispersion, and the propagation