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BOOK REVIEW

Shaul Katzir, *Sonar to Quartz Clock: Technology and Physics in War, Academy, and Industry*

Oxford: Oxford University Press, 2023. Pp. 368. ISBN 978-0-19-887873-5. £45.00 (hardback).

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Quartz, a crystalline form of silica, is a crucial material in the infrastructure of our contemporary world. Assembled with integrated circuits and a power source, slivers of quartz are at work in nearly every electronic device today. Despite that centrality, how quartz came to play such a large role is generally unknown, except to a relatively small group of researchers and technical practitioners. Similarly disregarded is the history of the fundamental property that makes quartz useful – the piezoelectric effect. The Curie brothers Jacques and Pierre first noted in 1880 that certain substances, when subjected to mechanical stress, generate electrical charges. The converse is also true. When subjected to electricity, certain crystals like quartz change dimensions, and they can also maintain a stable rate of vibration. Learning how to apply this piezoelectric resonance ultimately led to the establishment of a community of specialists and the invention of fundamental instruments for detecting sound and ultrasound, controlling electrical frequencies and building precision clocks. In the historiography of science and technology, few materials are so critical and yet so underexplored.

Shaul Katzir is doing his best to remedy the oversight. Piece by piece, his numerous publications address the history of piezoelectricity from its beginnings to the eve of the Second World War in varied academic, industrial and government settings. His works join a very short list of other histories that explain quartz crystals' unusual properties and substantial utility in the twentieth century – among them, Richard J. Thompson's *Crystal Clear: The Struggle for Reliable Communications Technology in World War II* (2011) and Christopher Shawn McGahey's 2009 dissertation 'Harnessing nature's timekeeper: a history of the piezoelectric quartz crystal technological community (1880–1959)'.

This book begins in the middle of piezoelectric history with a fresh look at how sonar research proceeded during the First World War and influenced the direction of research thereafter. Key was the foundational work of physicist Walter Cady, who identified piezoelectric resonance after his involvement in wartime submarine detection. Cady studied the behaviour of piezoelectric crystals, trained numerous students and convinced other researchers that crystal-based devices had utility. The author outlines how still other investigators took up frequency control and measurement, especially in the service of electrical communications technologies in the United States, Europe and Japan. He links these investigations in the interwar years to the development of the quartz

clock, a new kind of timekeeper more precise than any mechanical clock, with special emphasis on the first one developed at Bell Telephone Laboratories in 1927.

Themes of knowledge transfer and the transformative interplay between science, technology and invention are central to this book. The author examines how a community of researchers and practitioners formed and proceeded. For evidence he has scoured laboratory notebooks, other primary sources, published research papers and paper abstracts in *Science Abstracts* from 1920 to 1939. The result is a deeply researched case study with new details about the history of quartz and the phenomenon of piezoelectricity. The book offers evidence that technical applications of piezoelectricity originated in settings outside university research and influenced the direction of physics in the interwar period, developments usually associated with the Second World War and thereafter. The analysis places this history squarely among other scholarly explorations of science–technology boundaries, with clear evidence to support the claim of an iterative process of knowledge development. An effort to categorize that development in five evolutionary stages is less convincing.

This is not a book for those who seek a general introduction to the history of piezoelectricity. It is extravagantly detailed, demonstrating the author's close reading and deep understanding of source materials pertinent to a relatively tight span of interwar years. Although the book aims to show how science and technology work in context, it is short on connective explanations that link larger social, cultural and military interactions with the specialist community of investigators and practitioners. And the publisher has contributed to making this book difficult to read. Preparation for going to press seems to have skipped the copyediting stage, leaving abundant and distracting typographical errors.

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