



# Rethinking Thermoelectric Effects In Seebeck And Peltier Elements: Toward A Unifying Paradigm

*Michael Spry*

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It started as an introductory work on thermoelectrics, reviewing theory from the perspective of zero-sum energy balance within thermoelectric elements. This would involve the resolution of temperature dependencies using finite element analysis, and depend upon the maximum level of mathematical harmony among the effects. Energy balance would have to be demonstrated *everywhere* along the length of each semiconductor element. This work demanded a far greater attention to detail than the ‘system-level’, average-based assessments which have dominated theoretical discussion throughout most of the history of thermoelectric technology. Thus, it should hardly be surprising that a series of important insights and discoveries would emerge from this vantage point—phenomena that were hidden within the black box treatment of TE elements. The introductory book soon gave way to a paradigm-shifting research project open to re-imagining the energy interactions related to bulk properties in power generation and cooling. It was time to make all of the puzzle pieces fit *throughout* each element rather than be satisfied with summary mathematics that could mask gaps, issues, and misunderstandings.

In a thoroughly-illustrated and very detailed book, this 27-year veteran of the thermoelectric field, explores his research and reveals new hypotheses which are harmonious with energy balance throughout individual TE elements. Using new-concept visual aids which stem from computer models, he examines the codependency of temperature gradients and bulk properties in ways they have never been seen before, giving readers a far more intuitive grasp of thermoelectric fundamentals. While many prior concepts find support and utilization, others like Thomson Effect and 50-50 splits of Joule heat collection, are shown to be built upon fallacy. In the end, the author offers one of the most consistent and completely-integrated pictures of TE interactions ever assembled. It is a vision that can serve as a more substantial foundation for future theory—and which can provide illumination to enhance our understanding today.

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