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AUTHOR'S PREFACE

Regarding my work [...] I can honestly say that it's wonderful (as always!). Sometimes I feel that it was high time for Osram to hire someone with at least some background in mathematics, for there are employees here whose mathematical abilities are unbelievably primitive. Even Jacoby wouldn't be able to capitalize on half of his countless ideas if he didn't have me around to tell him right from wrong.¹

Iris Runge wrote these words in June of 1923. By this time she had been working for just three months at the Osram Corporation in Berlin, specifically at a research laboratory directed by the inorganic chemist Richard Jacoby. The eldest daughter of Aimée (née Du Bois-Reymond)² and Carl Runge, who is remembered today for his part in developing the Runge-Kutta procedure of numerical analysis, she belonged to the first generation of academically trained women in Germany and was an intellectual product of the renowned center of science and mathematics at the University of Göttingen. Following in her father's footsteps, Iris Runge was still a student when she wrote her first academic article, a study co-authored with the theoretical physicist Arnold Sommerfeld, whose integration of mathematics, physics, and engineering had set a new standard for research. She was held in high esteem, moreover, by the number theorist Edmund Landau and she was awarded a doctoral degree for a dissertation, written under the supervision of the physical chemist Gustav Tammann, in which she applied advanced mathematical methods.

The Osram Corporation, known chiefly for its production of light bulbs and electron tubes, was founded in 1919 and quickly developed into an international enterprise with ties to General Electric and other firms. Still in its infancy, and with its headquarters in Berlin, Osram hired Iris Runge and thus acquired the expertise of a researcher who would function as a bridge between mathematics and its applications. "Calculation instead of trial and error!" – on account of her influence – became a catchphrase in the company's industrial laboratories.

This book arose from the uncommon circumstance of there being enough sources – from private letters to academic publications – to enable a reconstruction of a female mathematician's path from her childhood throughout the length of her professional career. Although certain American companies, such as the Bell Telephone Laboratories, had established mathematical research departments relatively early on, the majority of firms in the electrical industry employed only a few individuals as mathematical consultants. Iris Runge worked as such a consultant at Osram from 1923 to 1939. When the Osram electron tube factory was acquired by

1 Iris Runge to her father, Carl Runge, in a letter dated June 6, 1923 [Private Estate].

2 Aimée Runge was the daughter of the physiologist Emile du Bois-Reymond and the niece of the mathematician Paul du Bois-Reymond, who developed the so-called Du Bois-Reymond lemma in 1879 and is known for his contributions to the calculus of variations.

Telefunken in July of 1939, she found herself among a group of similar researchers. The activities of these laboratory groups at Osram and Telefunken, whose research was devoted to incandescent bulbs and electron tubes, have never been examined before. This research activity will be treated here in light of its collaborative nature both within Germany and internationally.

Writing this book was an exercise in building bridges. First of all there is the bridge that connects mathematics to science, engineering, and business. It will be shown how the construction of this *mathematical bridge* was enabled by the formation of a center of science and mathematics at the University of Göttingen (Section 2.3), and it will be demonstrated in particular how industrial laboratories constructed mathematical bridges between statistics and the quality control of mass production; between the physical and chemical methods of materials research and the concrete problems of manufacturing conductors, filaments, bulbs, and electron tubes; and between the models of theoretical physics, and the design of scientific instruments. In other words, the book will describe the foundational approach to problem solving that is still characteristic of industrial mathematics. The origins of these methods, which were developed during the golden years of broadcasting and radio tubes (1920–1945), lie at the heart of this study, as do their causes and effects.

Second, this book hopes to build a bridge between the specialized fields of mathematics and engineering, and the general culture of a particular era. In the spirit of Theodore M. Porter, who has encouraged scientists to “put the category of the technical into historical perspective,”³ industrial products and the methods of industrial mathematics will be examined in the context of the social, economic, and political developments that unfolded from the time of the German Empire until the end of the Second World War. The book will thus offer a number of fresh insights pertaining to cultural history. Included among its topics, for instance, are the representatives of the middle class who endured the catastrophe of the First World War and became increasingly active in the politics of the subsequent years. Also to be addressed is the role of certain outsiders in academia (women and Jews in particular) who had managed to secure insider positions during the Weimar Republic but soon found themselves threatened by the political pressures of the Nazi dictatorship.

Third, the book hopes to build a bridge between the history of science and industry, on the one hand, and the fields of Gender Studies and Women’s Studies on the other. That its focus should be a woman scientist – and one with a broad interdisciplinary background – arose rather naturally from the fact that she was long employed as the sole mathematician at the Osram Corporation. While working there, Iris Runge was consulted as a mathematical authority by both scientists (physicists, chemists) and electrical engineers. By examining the life and work of such a researcher, insight was gained into the social and industrial conditions that

3 PORTER 2009, p. 297 (an original English quotation).

enabled a woman to achieve a prominent professional position, a position in an elite niche of industrial research that did not have to be abandoned despite the social upheavals of the time and the political opposition of the Nazi regime.

Chapter 1 presents an overview of the theoretical approaches that are adopted throughout the book. The second chapter examines why Iris Runge, a representative of the first generation of academically trained women, chose to forsake a traditional career as a schoolteacher for a position in the field of industrial research. Her roots in a large Huguenot family will be explored, as will her involvement in various extracurricular groups at an elite preparatory school, her academic training in applied mathematics and other disciplines at the Universities of Göttingen and Munich, her participation in the activities of reform-oriented secondary schools, and her engagement with certain scientific and political societies (*thought collectives*). Chapter 3 is concerned with the role of mathematics in industrial laboratories, particularly with graphical and numerical methods, statistics, and the problems that such approaches were used to solve. The structure of research laboratories and the place of mathematicians within these settings will also be discussed. Chapter 4 analyzes how social and political upheavals influenced Iris Runge's behavior and disrupted national and international cooperation among industrial researchers. Her interaction with George Sarton will also be related, as will the emergence of the history of science as a viable academic discipline. Chapter 5 summarizes the major themes of the book and casts a glance at the years after 1945. The Appendix contains a timeline of Iris Runge's life, lists of the articles and reports that she produced during her industrial career, and reproductions of other valuable source material.

The original German edition of this book was published in 2010 by the Franz Steiner publishing house in Stuttgart, and its positive reception by mathematicians, scientists, engineers, and historians of science motivated the production of the present translation.

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and with Reinhard Siegmund-Schultze (Kristiansand, Norway). A pivotal aspect of the book, namely its concern with the application of graphical and numerical methods in industrial contexts, could not have been treated in such depth without the insights that I gained at a workshop, led by Dominique Tournès and myself, which was hosted by the Mathematical Research Institute in Oberwolfach.

I owe special thanks to Helmut Neunzert, the founder of the degree program in techno-mathematics in Germany and the inspiration behind the Fraunhofer Institute for Industrial Mathematics, for furnishing the book with a thoughtful foreword. Initial funding for this project was made available by the German Research Foundation, to which I remain grateful, and I could not have completed the book without the generous accommodations provided by Herbert Mehrrens and the Department of History at the Technical University in Braunschweig. Access to the library at the Max Planck Institute for the History of Science in Berlin significantly facilitated my research, and for this I am especially grateful to Hans-Jörg Rheinberger, Jürgen Renn, and Dieter Hoffmann. I would like to express my cordial thanks to John Broadhurst and Hans W. Courant (University of Minnesota) for helpful information and to Ms. Anna Maria Elstner (née Runge) for the permission to read and quote from the papers left to her by her aunt, Iris Runge. For references, cooperation, discussion, advice, and support, I am indebted to numerous colleagues and to the directors and staff members at several archives, each of whom is acknowledged by name in the German edition.

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Renate Tobies
Jena – September 2011