Computational Music Science

Series Editors

Guerino Mazzola
Moreno Andreatta

More information about this series at http://www.springer.com/series/8349

Guerino Mazzola • Maria Mannone • Yan Pang

Cool Math for Hot Music

A First Introduction to Mathematics for Music Theorists

Springer

Guerino Mazzola
School of Music
University of Minnesota
Minneapolis, Minnesota, USA

Maria Mannone
School of Music
University of Minnesota
Minneapolis, Minnesota, USA

Yan Pang
School of Music
University of Minnesota
Minneapolis, Minnesota, USA

ISSN 1868-0305 ISSN 1868-0313 (electronic)
Computational Music Science
ISBN 978-3-319-42935-9 ISBN 978-3-319-42937-3 (eBook)
DOI 10.1007/978-3-319-42937-3

Library of Congress Control Number: 2016956578

Cover illustration: Cover image designed by Maria Mannone

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

All
enjoyment
is
musical,
consequently
mathematical.

(Novalis)

Preface

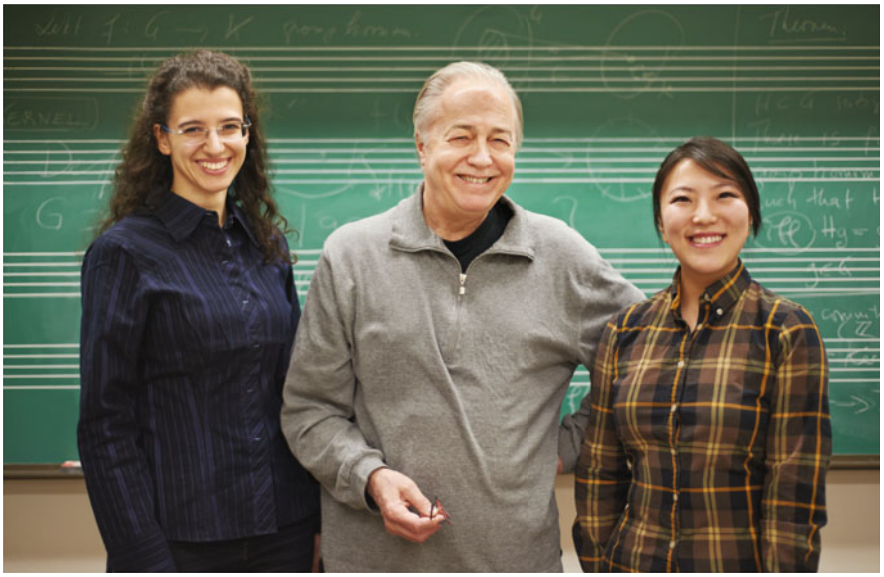

Fig. -1.1. Maria Mannone, Guerino Mazzola, and Yan Pang. Photo and © 2015 by A.J. Wattamaniuk.

The idea for this book came from Yan Pang, a PhD student taking the course "Mathematics for Music Theorists" at the School of Music of the University of Minnesota. She was not in love with mathematics at all—bad experiences, bad teachers, the usual story. Fortunately, Maria Mannone, another PhD student taking that course who had studied theoretical physics, helped Yan get acquainted with mathematical rigor and beauty. Soon, Guerino Mazzola, the teacher, learned how to teach math using thorough musical motivation

and avoiding abstract nonsense in favor of concrete conceptual development of theory.

One day, Yan confessed that she had become enthusiastic about mathematics for music in theory and composition (using both composition software and classical score writing), and she suggested that Guerino should consider writing a textbook in this inspiring style. He thought about her idea and in fact recalled that there was no *first* introduction to mathematical music theory. Guerino's book *Geometrie der Töne* [73]—the most elementary among his music theory books—was written in German and not conceived in a style that would meet the criteria of a *first* introduction. Given the enthusiastic experiences with Maria and Yan, Guerino approached his publisher, Springer, with a proposal to write this book with the two co-authors for a maximal advantage from the students' perspective. Springer did not hesitate a single moment, and we could immediately delve into this important project.

Accordingly, this book is not intended to present a dry mathematical text about tools that may be used in music. Rather, we want to develop a discourse full of pleasure and fun that in every moment motivates concepts, methods, and results by their musical significance—a narrative that inspires you to create musical thoughts and actions. We want to offer a presentation abundant in images, scores, and compositional strategies and enriched by audio examples from music theory and composition so that you can not only view the concepts but also experience them. However, to be handed tools with no opportunity to use them can be frustrating. Therefore, we also describe our concepts, methods, and results to help you apply them to your own unfolding skills in musical creativity. The wonderful advantage of a mathematical concept framework is its universal applicability, and this also includes its social dimension. The outdated ideology of a lonely genius who finds new creations in the trance of drugs and existential borderline experience is replaced by a collaborative and relaxed environment of global communication. This can accommodate any direction of musical creativity in the world of digital media and augment its power to shape the future of the beautiful truth of music.

Of course, nobody is forced to accept our offer, and it is true: The payoff will not show up immediately. If you want to challenge yourself with this colorful book, you will be given a tool for creativity and discipline for your whole life. But if you prefer to enjoy an easy life without any challenge beyond flat consumption, we wish you all the best in your cage of nothingness. However, please consider this book in case you change your mind and come back to the challenge of true beauty.

Mathematical examples and exercises are headed by
$\surd$ **Example**, $\surd$ **Exercise**,
whereas musical examples and exercises are headed by
Example, **Exercise**.

The reference to mathematical examples or exercises is "Example, Exercise", the reference to musical examples or exercises is "Musical Example, Exercise". The exercises are intended to be challenges for the reader to solve a problem by applying the concepts and results that have been presented in the text. Solutions to the exercises have been provided, but the reader should not consult them without first having tried his or her own approach. For this reason, the solutions can be found at the end of the book, in Chapter 34. The numbers of the solutions match those of the corresponding mathematical or musical exercises.

Mathematical theorems and propositions always need to be proved. This is mandatory in science whenever we claim the truth of a statement. All mathematical results that are shown in this book in fact do have a proof, but it does not always serve our purposes in style and depth to include the proof in our text. Therefore, we include references to published text where proofs can be found. We also sometimes give a hint to a proof and leave it to the reader to fill in details as an exercise.

Original illustrations, both computer and hand-made drawings have been created by the authors.

The music examples in this book are available as MIDI, Sibelius, and MP3 files. They are all accessible via
`www.encyclospace.org/special/MMBOOK`.
So if you look of the file `XX.mid`, you define the address
`www.encyclospace.org/special/MMBOOK/XX.mid`.

As in the previous books of this Springer series on performance theory and musical creativity, Emily King has been an invaluable help in transforming our text to a valid English prose; thank you so much for your patience with non-native English. We are pleased to acknowledge the strong support for writing such a demanding treatise by Springer's science editor Ronan Nugent.

Minneapolis, September 2015 Guerino Mazzola, Maria Mannone, Yan Pang

Contents