Opera House Acoustics Based on Subjective Preference Theory

Yoichi Ando
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This book's focus is on opera house acoustics based on subjective preference theory. Individuals not familiar with the subject are provided with a step-by-step presentation of the mathematical factors that characterize the subjective preferences of the sound field. Extensive references are provided with each chapter, so those so inclined to understand the subject matter at a deeper level or from a more detailed mathematical foundation are provided the references to more easily do so. The content allows exploration of the auditory-brain system in the fields of acoustics, as well as psychology and brain physiology. The organization of content is intended to assist the reader in understanding subjective attributes in relation to objective parameters based on this contemporary model of the auditory system.

Since the 1980's, there has been notable progress in temporal- and spatial-primary principles of sound and subjective preference based on neural evidences in the auditory-brain system. Yochi Ando was a leading researcher in this field in the early 80's, when case studies and computer analysis of the data were the available tools of research. Chapters 2 and 3 of this book restructure the surfeit of parameters from the computer era into four independent parameters. Ando begins his book by defining the running autocorrelation function to prove that it contains the same information as the power density spectrum, which allows the definition of the auditory experience in the time domain. This in turn opens the door to a definition of what we hear that is not fully addressed by the Helmholtz theory, which was based on a peripheral model of the auditory system. Ando then further details how past methods do not properly model pitch, timbre and duration as well as the spatial sensations, as does subjective preference theory. Chapter 4 presents Ando's original point of view of perception.

The use of magnetic resonance imaging (MRI) to view brain activity has facilitated the comprehension of the auditory-brain system and the relevance of subjective preference theory. Neural activities have been discovered related to subjective preferences of the sound field. A general strategy evolved from the use of the MRI that agreed with the original case studies for the design of an opera house to characterize what a person experiences (percepts) and what they prefer to experience, optimizing their environments to realize their preferences. Percepts involve time and space; such that temporal and spatial factors determine different sets of experienced qualities. The temporal criteria drive the left hemisphere, while factors related to spatial patterns engage the right hemisphere. The subjective preference theory is modeled to serve as the bridge of the right and left brain in the auditory experience. Any overall personal responses such as speech recognition, reverberance and/or the sound field can be well described by temporal factors extracted from the running autocorrelation function (ACF) and spatial factors from the interaural cross correlation function (IACF), which is explained in Ando's book.

The neural connection between perception and preference is then presented in Chapters 5 and 6. Chapter 7 presents the link between temporal and spatial factors and physical parameters easily evaluated in the field and demonstrated for an existing opera house. The reverberance of the sound field is then examined for an existing hall, using the four orthogonal factors presented in prior chapters. Chapters 9–12 then provide an overview as how to improve an existing opera house based on subjective preferences and then conclude with the subjective preference theory design theory for a new opera house design. The presentation of subject matter on room optimization is provided in a format that is of value to acoustic engineers, as well as for both performers and designers. With the recent growth of virtual reality glasses and systems, the understanding of subjective preference theory takes on a greater importance for all applications and will become an important thread in the opera house design.

This book is part of "Mathematics for Industry" (sometimes abbreviated as MI) series that is intended to serve as a mathematical foundation for creating future research and technologies. The various mathematical concepts are clearly and succinctly summarized in combination with drawings and diagrams. This combination of mathematical concepts illustrated by visuals creates a content that can be understood by designers and performers that do not easily use mathematics, as well as engineers and mathematicians.

Bonnie Schnitta
SoundSense, LLC
Wainscott, NY, USA
bonnie@soundsense.com