Remarks on Musical Application

Enclosed is the introduction to a paper describing a psychoacoustical model developed by David Rothenberg of The New York Research Group, Inc. It was developed for musical application and a musical instrument capable of utilizing its results has been constructed. However, the details of such an application are not evident from perusal of the technical paper which concentrates on generating quantitative predictions pertaining to the perception of musical tones.

Computations have been performed which show the application of the mathematical model to existing music, and results are consistent with both Western and non-Western musical practices. Computations have also been performed which apply the model to musical materials not yet known or exploited. The instrument previously mentioned is capable of exploiting such materials as well as performing music already extant (both Western and non-Western).

This investigation is intended to provide the acoustical engineer and composer with information comparable to that possessed by the civil engineer and architect pertaining to the availability, strength, and variety of materials. No attempt is made to deal with those aspects of musical composition which are concerned with musical content or ideas. No

system of composition is proposed. What is carefully studied is whether a musical stimulus in a particular musical context will be perceived as intended. This is analogous to the architectural question of whether a particular building will stand under actual load conditions. Although this affects the design of the building, no limitations on its appearance or aesthetic content results.

The Taj Mahal was built before appreciable scientific results on strength of materials were developed. Similarly, Mozart wrote without the benefit of this model. In both cases the results are in accord with subsequent theory, but the artistic value is dependent upon other factors. Also both Mozart and the architect of the Taj Mahal had the experience of their predecessors to guide their intuitions. However, consider the case of a Chinese composer using the ancient Chinese pentatonic scale who never heard any Western music. If suddenly a technical advance provides him with the resources of the Western orchestra with Major and Minor seven note scales and with equal temperament, his experience will be a less valuable guide to his intuition. It is improbable that he will produce even minimally acceptable results for quite some time --- perhaps more than his lifetime.

If, however, he possessed a description of the figured bass system

or any standard theory book (whose contents are based on the practices of many Western composers), his experimentation with the new materials would be more efficient.

All Western musical theories for existing music can be shown to be special cases derivable from the mathematical model being discussed. Those Western composers who are interested in exploring new musical materials, may, like the hypothetical Chinese composer, receive assistance which will eliminate waste from their experimentation. Such assistance would be no more restricting or valuable than a strength of materials table would be to an architect who is attempting to design a building made of a plastic material never before used.

The musical instrument designed for this study is uniquely flexible. It is capable of producing as many as thirty-one simultaneously sounding tones for each octave over a nine octave range. Both pitch and timbre may be simultaneously controlled from two distinct keyboards. It is also possible to control timbre by the setting of switches. There is separate control over attack time, decay time, sustain level, input waveshape and the frequency and amplitude of eight filters. There are four such banks of controls, each continuously variable and individually switchable to one another. It is possible to reproduce approximately almost any desired

timbre. The keyboard is rectangular and stepwise, similar to the one developed by Prof. A.D. Fokker and presently in the Teylers Museum in Haarlem, The Netherlands. It is separable into two manuals, each with separate timbre controls. The keyboard is symmetric; that is, the fingering of each key of any scale is identical. The conventional piano fingering of the C Major scale is retained except for a minor alteration, and the instrument is in many ways easier to play than a conventional organ despite its much greater complexity. Each of the thirty-one tones may be individually tuned and any of these may be switched off the key-board.

When the instrument is tuned to thirty-one tone equal temperament conventional Western music may be performed (in "mean-tone" tuning) as well as the majority of non-Western music known. All computations relevant to the use of such equal temperament system have already been performed and are available for use.

It is of interest that using the resources of thirty-one tone equal temperament as realized on the instrument, the theory indicates that it is possible to construct music which is tonal and both harmonic and melodious in the usual meaning of these terms as applied to Western classical and baroque music. This music should be appropriate for