



Fractal Design in Japanese Gagaku music: Performance analysis of *Goshoraku No Kyu*

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Identifying the nature of structural evolution of a musical work through observation of pattern propagation on multiple levels of scale, leads us to an abstract, formalized design that can be related to a number of non-musical processes and classified according to its complexity. This approach to music analysis enables us to view music, regardless of historical or geographical background, as an intuitive reflection of natural laws, fully integrated in our environment and everyday lives.

The founder of Fractal Geometry of Nature, mathematician Benoit Mandelbrot, opened the door to understanding structures on the verge of chaos and pointed to their presence in nature as well as in art. Soon after, the chaos theory, complexity theory and Stephen Wolfram's computational universe made bridges between disciplines that can't be ignored. Computer simulation of various processes through evolution of cellular automata, being deterministic under the same initial conditions, proved to be an excellent way to experiment with pattern propagation, observe a balance between order and randomness and determine the complexity of a structure.

After receiving a commission for a piece that makes bridges from Japanese traditional music to modernity, I faced a serious challenge: fascination with Gagaku music, so perfect that adding or taking away anything from its structure would just destroy its beauty. The simple generative musical cells almost immediately reminded me of two-dimensional cellular automata represented by evolution of black and white cells resulting in an endless number of structures, from simple to highly complex. I attempted to transcribe and then map the performance of *Goshoraku No Kyu*, by the Imperial Court Ensemble, to a two-dimensional substitution system, analyze its complexity and recreate it in my own way.

This paper documents the mapping process, gives the interpretation of the structure of the piece and proposes classification of its complexity. The generative cell of the entire composition seemed to be based on binary opposition: stable vs. unstable. Each measure carried this cell in a very clear way. Further, I observed transformation of the cell: the measures were grouped by two and then by 4, 8 and 12. Adjacent groups, on each level of scale, mirrored each other according to the same binary principle thus forming a typical self-similar, fractal structure. Still, the most fascinating feature of the piece was insertion of irregularities and their compensation balancing the overall form and taking it from the realm of a formalized structure to an extraordinary piece of art.

Graphic interpretation of *Goshoraku No Kyu* based on binary opposition.

