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## Preface

The idea of using brainwaves to make music dates back from the 1960s, when composers such as Alvin Lucier, Richard Teitelbaum, and David Rosenboom, to cite but three, looked into generating music with the electroencephalogram, abbreviated as EEG.

Lucier placed electrodes on his own scalp, amplified the signals, and relayed them through loudspeakers that were “directly coupled to percussion instruments, including large gongs, cymbals, tympani, metal ashcans, cardboard boxes, bass and snare drums” (Lucier 1980). The low frequency vibrations emitted by the loudspeakers set the surfaces and membranes of the percussion instruments into vibration. Teitelbaum used various biological signals including the EEG and ECG (electrocardiogram) to control electronic synthesizers (Teitelbaum 1976). Rosenboom subsequently looked into designing more sophisticated systems inspired by Cybernetics, exploring the concept of biofeedback in real-time music making (Rosenboom 1990).

Those pioneering composers left an important legacy of concepts and practices. However, apart from very few sparse initiatives here and there, the idea seems to have faded into oblivion until the end of the twentieth century. We reckon that one of the reasons for this stagnation is that EEG equipment was not as widely available as it is today. Moreover, techniques for analyzing EEG signals were not as well developed as they are today, and consequently we lacked sophisticated handling and understanding of the EEG.

A notable development for musicians was the appearance of a piece of equipment called BioMuse in the 1990s, manufactured by Benjamin Knapp and Hugh Lusted (1996). BioMuse provided a portable kit for digitally processing bio-signals such as the EEG, muscle movement, heartbeat, and so on. It was able to convert these signals into MIDI data, which facilitated the implementation of MIDI controllers using the EEG.

Within the last two decades or so, we have witnessed the emergence of the field of Brain-Computer Interfacing, or BCI (also referred to as Brain-Machine Interfacing, or BMI). Research into BCI is aimed at the development of technology to enable people control machines by means of commands expressed by signals, such as the EEG, detected directly from their brain. Most of this research is developed within Biomedical Engineering and is aimed at giving severely paralyzed patients the ability to control artificial limbs, wheel chairs, robotic equipment, machines, and

so on. Obviously, in these cases, the user must be able to actually control these devices voluntarily and as precisely as possible. The user needs to produce specific patterns of EEG to command a machine and such a machine needs to interpret those patterns and do what the user wants it to do.

Continuing progress in BCI research combined with the emergence of more affordable EEG equipment are fostering a renaissance of approaches to making music with brain signals: the field of Brain-Computer Music Interfacing, abbreviated as BCMI, is now well established (Miranda 2010).

The field of BCMI has developed in tandem with the field of BCI. As with BCI, in BCMI the notion of active control of a system is an important aspect (Miranda et al. 2005; Miranda et al. 2003). However, the notion of control in an artistic application can, and should, be approached with flexibility. There might be cases where a composer might want to avoid explicit control altogether. Nevertheless, in order to make progress, the science and engineering behind BCMI research should be aimed at the development of control methods as well as approaches for mapping EEG information into musical information. In practice, composers may of course choose to ignore all of these, depending on what they want to achieve.

A number of low cost EEG equipment have been appearing in the market, most of which are commercialized in association with some sort of system for aiding meditation, relaxation, and so on. Whereas these have given musicians wider access to such technology, at the same time, however, pressures to manufacture them at low cost mean that the great majority of these systems fail to relay a reliable EEG signal for processing. This is an important fact we should all bear in mind, including those who are not so concerned with active control. Even in those cases where we might not wish to harness the EEG signal for explicit control of a music system, we do need a reliable EEG signal nevertheless. Otherwise we might end up making music with signals that are anything but the actual EEG. Therefore, the essential ingredients for making progress in the field of BCMI are: reliable hardware, powerful techniques for EEG signal processing, and creative methods for rendering the EEG signal into music. *Guide to Brain-Computer Music Interfacing* brings a number of chapters reporting on developments for the last two ingredients.

This book emerged from a workshop on EEG and music composition that took place in 2011 at the University of Bordeaux, France, supported by the French Association for Musical Informatics (Association Française d'Informatique Musicale, AFIM). The workshop included presentations that were entirely technical, focusing on hardcore EEG analysis, and ones that focused on practical musical applications. This is reflected in this book, but in addition to chapters developed from papers presented at the workshop, we also commissioned chapters from experts on topics that were not covered by the workshop.

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