Digital Musical Synthesizer as a Modern Hardware and Software Complex for Training Music Computer Technologies

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Abstract: *Art occupies one of the most significant places in the formation of a student's creative personality. The article is devoted to the consideration of a new approach to comprehension of musical art in the process of co-creation with students through digital technologies, which, in fact, are the basis of a new subject area in musical education (general and professional). The professional educational activity of a music teacher in a modern recording studio is an instrument of creative work in a high-tech information educational environment, accessible and understandable to students from universities, as well as secondary schools. The article provides guidelines for conducting classes in a modern recording studio, identifies the necessary components of the organization of the educational process in the context of teaching music disciplines*

Keywords: *Digital Musical Synthesizer, Electronic Musical Instruments, Hardware And Software Complex, Music Teacher, Music Computer Technologies, Musical Computer, Musical Creative Activities, Musical Education, Sound Engineer*

1. Introduction

The formation of a full-fledged educational environment for a musician teacher equally involves a serious methodological filling of educational disciplines related to the teaching of music computer technologies (MCT) [1; 2; 3] and material and technical means for their implementation. For the process of teaching in the new educational field of activity and the full study of the disciplines of the direction "Music computer technologies in education", it is necessary to have a music computer class and a training computer recording studio. The MCT-class is mainly intended for group lectures and practical classes, while the training recording studio is a place for practical and individual lessons [4; 5]. The equipment of the training studio involves special acoustic processing of the premises, the creation of a high-quality digital sound recording complex, and the studio is equipped with a park of necessary equipment. The hardware-software complex of the studio should be equipped with professional studio equipment and full versions of the software for the professional activity of a musician. Sound engineering is a creative profession related to recording and processing sound, creating sound artistic images. As a rule, he owns both the artistic and technical aspects of working with musical material [6; 7]. The sound engineer needs to understand both the musical material of the recorded work, so to know the physics of sound, to understand musical acoustics, and psychoacoustics, instrumental studies, own, including modern musical instruments - electronic musical instruments (EMI), including music computer technologies as a means of teaching the musical art for visually-impaired people [8; 9].

The latest trend introduced by AI in the music industry is composing music using machine learning algorithms. Despite the fact that «artificial» music is still far from the works of great classics, algorithms have already managed to achieve amazing results.

2. Consider The Main Areas of Activity of the Teacher-Musician as a Sound Engineer in a Training Recording Studio

The teacher-sound engineer records, processes, mixes sound components using the technical means of a training sound studio. The study of the technical and musical aspects of sound recording with students is carried out on the example of creating musical compositions. Recording musical material is necessary for analyzing errors and preserving invented sections of parts of future compositions. It can be like an interesting drum break, a melodic solo, or any other element of a musical work.

There are several levels of recording quality: draft, multi-channel demo recording, studio recording.

Studio recording is made in acoustically prepared specialized premises, on professional equipment, by highly qualified specialists. The result is a finished work that meets the requirements of the modern sound industry (for example, to release an album, rotate on the radio, post on the Internet, etc.).

At the initial stages of work, draft and demo recordings are most relevant. Draft recording is done using improvised tools such as a mobile phone and voice recorder. Such a recording is performed for sketches of future compositions and provides a quality sufficient to work on the material and its preparation for better processing.

Multichannel recording is carried out by sequentially recording instruments in one channel or simultaneously recording instruments in several channels using microphones of the appropriate type. Multichannel recording requires additional equipment, such as mixers, specialized sound cards, preamps, studio monitors, headphones, a personal computer with sound recording software. A multi-channel demo recording is performed to familiarize and evaluate the material, since it is able to reflect the idea and show the abilities of a group of performers. Obviously, the rough recording is completely unsuitable for these purposes.

A multi-channel demo recording differs significantly from a draft recording, but, as a rule, it does not correspond to the quality of a studio recording due to the class of equipment used and the experience of a sound engineer performing information. In fact, a studio recording is a multi-channel recording made by professionals on the appropriate equipment, the result of which is a finished product.

The main advantages of multi-channel recording are:
• the ability to work with each batch individually (detailed batch analysis, correction, processing, panning, etc.);
• the accuracy of the transmission of the sound of the instrument through the use of individual means of removal and signal processing (microphones with the corresponding dynamic and frequency range);
• the possibility of high-quality mixing of instruments in a common mix in frequency and volume.

In the process of preparing a demo recording, musician students recognize the importance of working with a metronome, delve into the nuances of sound production and sound formation, and hone their skills. After creating a good demo, you can consider the musicians almost ready for studio recording without spending extra studio time on preparing the material.

3. Recording Equipment. The Room

The acoustics of the room have a direct effect on the sound of the signal recorded through microphones, as well as on the reproduction of sound through the speaker system. Most of the usual rooms, as a rule, are not prepared for high-quality work with audio material, since they contain unwanted reflections, reverb and standing waves that interfere with correct clean recording and control of the result. Acoustic decoration of the room is required, in which special acoustic plates are used, placed in a special way at selected points.

Mixing music in an unprepared room leads to an incorrect assessment of the spectral composition of the signal and the volume level of certain frequencies: the sound "walks", signals of close frequencies are randomly added and subtracted, which leads to illegibility in evaluating the elements of the composition.

Microphones. Microphones are divided into several types: condenser, dynamic vocal and instrumental, they differ primarily in directivity (omnidirectional, cannon microphones, supercardioid, cardioid, eight, etc.), sensitivity (the ratio of the signal at the microphone output to the volume of the input signal), frequency response (sensitivity at different frequencies) and scope (recording vocals, acoustic instruments, electric guitars, drums).

Dynamic microphones have a high overload capacity and a rather narrowly directed characteristic and are most often used for concert vocals (to reduce the possible high-frequency generation), for picking up a signal from powerful instruments - guitars, bass guitars. To pick up the signal from the bass drum, dynamic

microphones with an increased diameter and linear stroke of the membrane are used. Condenser microphones are usually used for those instruments where the transmission of volume and nuances of sound is important, such as studio vocals, acoustic guitars and drum metal. It should be noted that for such microphones additional phantom power is required.

Mixing console. The mixer during entertaining events (concerts, performances, public performances) is intended for picking up signals from instruments on the stage, mixing the general mix on-line, equalization and frequency correction of individual instruments, followed by signal output to spectators in portals and musicians in monitors. Basically, the size of the mixer depends on the number of channels. The functional purpose of them is almost the same.

In the process of sound recording, the mixer is used for slightly different purposes. When recording a large group of students, 15-20 microphones may be required at the same time. In fact, if there is a multi-channel sound card, each instrument is connected to the corresponding channel and recording is performed. In this case, a mixing console is not necessary. If it is necessary to carry out multi-channel recording in the presence of a card with 2 or 4 channels, several instruments are preliminary reduced to the level on the mixer (compression can also be added, equalization and panning performed), and the stereo output of the mixer is output to the line input of the sound card. It is worth noting that in this case, individual post-processing of tools is excluded. During rehearsals, a mixer is also actively used - for example, for a barrel, vocals, backing vocals, etc.

Sound card. The sound card is designed to amplify, digitize and process in real time the input analog signal. In the case of digital interfaces (MIDI, SPDIF), amplification and digitization are not required. A modern semi-professional sound card should have a sufficient number of channels, the ability to expand the number of channels, high-quality signal amplifiers for dynamic microphones, phantom power condenser microphones, MIDI input for writing drums and synthesizers, a digital input SPDIF for recording signals from processors without dual analog-to-digital and digital-to-digital analog conversion (DAC-ADC).

Significant is the presence of audio streaming protocol - ASIO. The quality of implementation of this algorithm is characterized by the time that elapses from the moment the signal appears at the input of the sound card to the signal output to the monitors. On good models, the delay time is 2-3 milliseconds. This parameter is especially important when real-time signal processing by emulators of guitar effects and synthesizers (FL Studio, Guitar Rig).

Useful when recording are functions to control the level of the input signal, the ability to turn off the signal output to monitors, as well as access to independent pairs of headphones for individual monitoring of members of a group of musicians.

Studio monitors and headphones. Studio monitors are structurally similar to ordinary household speakers. However, high-quality monitors have a linear frequency response, i.e. reproduce at the same volume level all frequencies in the audible range (from 20 Hz to 20 kHz) and have high sound detail - the part of each instrument is heard separately. The task of monitors is to transmit sound into space in the most undistorted form. The sound engineer using monitors works directly with the original spectrum of the signal, which allows for the correct mixing. The location of the monitors themselves relative to the floor, walls and each other, as well as the position of the listener, have a significant effect. For minimal distortion in the low-frequency region, monitors should be located a meter from the walls, the tweeter (due to the narrow focus of high frequencies) should be at ear level. Monitors are located at the vertices of an equilateral triangle, in the third vertex of which is a sound engineer. The monitors should be set to the same volume. Incorrect configuration of monitors and their location will lead to errors when mixing the composition. Note that studio monitors are not designed for comfortable listening to music. Their goal is to show all the flaws of the composition.

4. Conclusion

To analyze especially critical moments of the composition, quiet sounds and small details, sound engineers use studio headphones. Their goals and objectives are the same, however, they are insensitive to the acoustics of the room and allow you to work with sound in the presence of extraneous noise. Headphones do not give an adequate stereo picture, so the final mixing is done on monitors. When working on a track, you must have both tools. (However, the sound engineer's main instrument is his ears. A tired hearing or irreversible deterioration

will negate the characteristics of expensive equipment.)

Personal computer (PC) specifications and recording software. Logic ProTools and Cubase are used in studios around the world, as well as Windows and Mac. The quality of signal processing mainly depends on the plugin used. For example, you need to purchase the appropriate hardware for the Pro Tools package, which will be responsible for processing without loading the PC processor. Using one of the listed programs, you can get high-quality musical material in a training recording studio [16; 17; 18; 19].

We consider it appropriate to teach music students the basics of studio recording using the Steinberg Cubase program as an example, which will make it possible to switch to other software in the future. Sound recording and mixing can be carried out on a modern two or more PCs with a RAM capacity of at least 4 GB and a large hard disk, because a project of one track can take up to several gigabytes of disk space.

Thus, studying the course of practical sound engineering in a modern recording studio allows musicians to fully master the instruments of recording, processing and mixing of musical material.

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