1.0 Introduction

At the heart of all audio recording and production facilities is the audio console or mixer. The basic function of the console is to provide a means of routing audio signals among microphones, audio recorders/players, and amplifiers. In addition to its routing capabilities, a console usually allows the manipulation of signal characteristics such as the sound levels and equalization. Depending on the particular needs of the production facility, the console may also be used for sending/receiving signals to/from effects processors or other special purpose audio processing equipment.

The Compendium DSP-2000 series is a family of multi-processor computer audio consoles developed in a two-year effort specifically to meet the needs of commercial and institutional digital sound production facilities. The DSP-2000 audio consoles present an opportunity for musicians, composers, and producers to employ the functions of traditional audio consoles digitally, and gain the advantages and flexibilities of computer sound production. These functions include the programming and control of signal paths, equalization, sound levels, signal selection, and automation. A hard disk based on-line "music workspace" makes it possible to implement such functions as recording, editing, modification, and random-access playback of audio.

2.0 The DSP-2000 series audio computers

The specification of the DSP-2000 series initially evolved from the development system used by Compendium engineers in developing the DSP-1000 plug-in based consumer audio computer. It soon became apparent that a professional level, hard disk based audio computer could be designed that would serve professional recording, editing, and film/video sound production applications. What emerged was an all-purpose system requirements (Schwartz, 1986).


- High resolution analog to digital and digital to analog converters with user-selectable sampling rates
- Digital mixing
- Digital equalization
- Digital recording with virtual multi-tracking
- Digital routing for sends, track assign, and effects
- Gigabyte modules of on-line magnetic disk storage
- Mix-down to various digital stereo formats: ELA, Sony, and Compendium
- Optional digital reduction of audio for increased storage capacity
- MPU-41 time code master and slave modes
- Color graphics with semi-animated 3D representations of the audio signal
- Music file editing
- Disk Version 7 System III compatibility
- Telecommunications capability

In addition to these functional specifications, the following constraints were followed by the DSP-2000 design team:

- Equipment cost must be competitive with highend analog units
- The user interface must be intuitively obvious
- Controls must be intuitively obvious
- Any system commands must be in plain English
- The systems must be modular at all levels
- A four-channel system must be small enough to move easily through doorways fully assembled and/or 19' rack mounted
3.0 System Configuration

The DSP-2000 is a modular, integrated audio computer. Separate external enclosures (3 1/4" by 17" by 19") contain each functional module; audio input/output (I/O), central processing unit (CPU), and music workspace (magnetic disk data storage), a computer (see accompanying display).

The I/O module contains up to eight channels of analog to digital/voluntary converters, allowing such combinations as 2×2 (2 A/Ds and 2 D/A's), 4×2 (4 A/Ds and 2 D/A's) and so on. Each converter is 16-bit, linear with a maximum sampling rate of 10 kHz. The I/O module also contains anti-aliasing and anti-imaging filters, on analog buffering stage, and power supply.

The central processing module contains the system bus, processors, and power supply. The Intel 8086 (Intel Corporation, 1982) was selected as the system bus for the DSP-2000. Existing board level Multibus plug-in modules for CPUs, memory, DMA, graphics, and other functions were selected. Additional Compaq-compatible Multibus modules were required to extend the Multibus into audio processing. These modules include an interface between the Multibus and the A/D and D/A converters, a dual TRM320-based signal processing module, and a high-speed telecommunications interface. The host CPU is an Motorola MC68000 running Regulus, a Unix system III compatible operating system.

The music workspace module contains from one to four 5 1/4" hard disk drives. Each drive currently holds 143 Megabytes. Since this capacity will be increased to 190 MB, and then 380 MB per disk, the total capacity of all four drives of music workspace module is currently 80 minutes of mono or 40 minutes stereo, 20 quad, etc., at full 10 kHz sampling rate. By using the optimal data reduction signal processing stage, this capacity can become greater than 240 minutes. A maximum of eight four-drive modules can be used with the DSP-2000, currently yielding a total of 4576 Megabytes of on-disk storage.

A trackball array panel, keyboard, and 19-inch color monitor serve as the hardware for user control. The trackball array consists of a flat panel with 30 trackball stations. Each station includes a trackball and three mouse button contact switches.

4.0 User Control

A user controls the DSP-2000 through the keyboard and trackball array. First, the keyboard is used to call up the various programs and processing configurations. A color graphics monitor then displays the signal processing configuration and trackball assignments. The trackballs may then be used for controlling levels, gain equalization, and other parameters.

As an example, when the 4×2 input program is invoked, a color graphic image of a conventional mixing console appears on the monitor. The image has input and output VU meters, low, mid, and high frequency equalization knobs, pan knobs, signal level faders, and switches. The function of each trackball is to match the corresponding location of each control on the monitor. The momentary contact switches on the trackball array panel also match the switches pictorially on the monitor for "mute," "solo," and specialized functions such as "rescale" and "select parameter." In the program run, the VU meters, knob positions, and faders are displayed in real-time to reflect the signal levels and positions of the user controls. The trackballs and switches may be manipulated to change levels, pan the signals, and provide special effects.

Another example is the video sound effects editor program, which is controlled by the small numeric keypad on the keyboard. A diagram of the keypad containing the commands appears at all times on the monitor. Using single stroke keypresses, the user can perform and audition the directory of sound files. Once a soundfile has been selected, edit mode is entered by pressing the key on the pad labeled "edit." The virtual keypad, at all times displayed on the screen, is redefined as edit mode is entered. The previous options are replaced by new options which allow forward and reverse scanning of the selected soundfile, marking of audio "ins" and "outs," editing, and synchronization to SMPTE timecode. After reentering the edit, the user has the option to perform the edit, or to save the edit to an edit list being assembled for playback later.

Other programs are available on the DSP-2000 for operations such as music editing, music synthesis, data reduction, and signal processing.

5.0 The Future

At present, the number of audio channels available on the DSP-2000 is limited by the bandwidth of the Multibus. Computers is currently implementing a high-speed synchronous bus to alleviate this bottleneck (Schwede, 1984). This will allow expansion of the DSP-2000 to as many as sixty-four or more channels of audio.

Other features which will be available include a high-speed reduced instruction set processor to execute a variety of filterbank algorithms in real-time (Schwede, 1985), and a TRM320-based signal processing module for real-time special effects and music synthesis.
REFERENCES


