

An Overview of DSP for Live Sound

for Church Production Magazine

by David Kennedy

DSP (Digital Signal Processing) units for live sound reinforcement come in a wide variety of shapes and sizes. Let's organize this extensive range of DSP components into organized groups in order to understand what they can do and how they differ.

Background & Terminology on DSP

We will start with a little background information and some history on the early products. DSP's are rated in bits, like the processor in your PC. For comparison, DSP units with 16-bit D/A (digital to analog) converters are known as CD (Compact Disc) quality, since the CD recording process is 16 bits. Low cost DSP's of the early 80s had low sampling rates, limiting their high-end response and dynamic range (causing noise or distortion). Currently 32-bit DSP's with 20- to 24-bit D/A converters are the norm.

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The advantages that DSP's have over their analog predecessors are numerous, including more tamperproof, less filter drift and no control noise. They also have greater precision and repeatable accuracy, as well as recall of settings, and good value.

Digital Delay and Effects Units

Widely spaced loudspeakers can cause troublesome echoes. Delay units can be used to align the "time arrival" of the signals. The forerunners of DSP's for live sound were digital delay units, providing a "solid state" replacement for the electro-acoustic devices that were in use for under balcony delays and echo-effects. The 1980's saw the introduction of DSP's with user-adjustable parameters for electronic reverberation and effects. While popular in entertainment applications, this type of DSP (known as FX) has seen limited use for church-sound installations.

Lexicon and Yamaha developed their own DSP and converter chips early on, to maximize their performance. TC Electronic has also become a market leader and now has a wide range of high-quality DSP units.

Other specialized DSP units by LCS and LARES are used to build highly sophisticated multi-channel surround FX and electronic-acoustic systems.

Feedback Eliminators

on-board software to reduce feedback by automatically applying narrow-notch band EQ

Sabine introduced their DSP-based feedback eliminators (FBX) over a dozen years ago. The FBX units were an amazing innovation that used on-board software to reduce feedback in a sound system by automatically applying narrow-notch band EQ (equalization). While 1/3 octave-type graphic EQs (30 band) were an improvement over the octave (10 band) type EQ's, they cannot compare to the newer PEQ's (parametric equalizers) that are user-controllable from .01 to over one octave wide. These **remove much less of the program material** as compared to traditional graphic EQ units.

The Sabine units were a breakthrough technology, however, they were not a replacement for substandard equipment in the rest of the signal chain, or improper system design and operation. First generation FBX units did improve gain-before-feedback, but at the cost of limited dynamic range and accidental notching in the presence of sustained music, sometimes compromising the sound quality.

For multi-use systems the best way to do automatic notching was to insert an FBX on input channels or sub-groups of mixers that control the speech and vocal mics that need maximum gain-before-feedback. The FBX units have since been greatly improved to include an algorithm that distinguishes music from feedback.



DSP chip (IC)

These later units also improved on the dynamic range by including better chips and limiters. Side effects are so minimal that they can be considered for use in the output buss of

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multi-use sound systems. More recent FBX units include switchable parametric filters that are user programmed from a PC to do the main EQ functions. Several other manufacturers currently offer units with similar features; some of the most popular are from Shure and Peavey.

Digital Mixers

Allen & Heath introduced some basic, hands-free digital mixers in the mid 1990's that are still popular. Mackie has since countered with a more full-featured unit.

Although new products are on the way, most of the current DSP-based mixing consoles are best used for recording or pageant series projects, or are very costly; thus they will not be discussed here, beyond noting TOA and Yamaha's leadership in this area and recent offerings from Soundcraft.

Single Purpose DSP Units

About the same time as Sabine was developing its FBX units, other manufacturers were offering specialized DSP-based delay, effects and equalizer units with increasing quality. While programmable through their front panels, these early, specialized-DSP units were limited in their capability and varied in user friendliness; many were little more than DSP versions of analog EQ's.

The studio side of the industry embraced digital recording many years ago, and standardized a digital I/O (inputs and outputs). But it was not well supported in the live-sound DSP units. Thus, if a sound system designer wished to use several specialized DSP's in series there were few units available that offered the digital I/O required to interface the units in the digital domain. The common practice was to hook multiple DSPs in series (like analog units), but the multiple D/A converters reduced dynamic range.

Large/Scalable DSP

In the early 1990's, the guys at IED (Innovative Electronic Designs) and Peak Audio revolutionized the industry by creating large-scalable (expandable) DSP systems for live sound.

Large amounts of DSP were mounted on circuit cards along with 8-channel 16-bit D/A converters and both were installed into card frames.

the Media Matrix was much easier to reconfigure than any previous system.

Peak Audio's technology was licensed by Peavey and marketed as MediaMatrix. This was a breakthrough technology for designers of very-large systems, allowing very complex systems to be conceived and easily programmed in advance, including a long list of virtual components. Better yet, the Media Matrix was much easier to reconfigure than any previous system. These DSPs and converters were also easily scalable, meaning they could be stacked on a digital buss, keeping all the DSP functions and interconnecting signals in the digital domain, **maximizing performance and eliminating much of the rack wiring.**

The Allen & Heath basic-digital mixers later developed into a system similar to MediaMatrix, known as Soundweb by BSS Audio. The Soundweb units were familiar looking 1U rack units with a feature set much like Media Matrix but including better 24-bit D/A converters.

a rich feature set including remote control, total-recall, delay, EQ and loudspeaker processing

Biamp, BSS/Crown, ClearOne, IED, Peavey, Rane, and Symetrix now offer 24-bit, scalable and configurable DSP units. These units offer a rich feature set including remote control, total-recall, delay, EQ and loudspeaker processing; most offer a selection of I/O configurations and a "drag and drop" user interface, making them



BSS Soundweb remote control

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highly flexible. These scalable DSP's also offer auto-mic. mixer and gain-riding features, needing only amplifiers to complete the electronics in a "hands-free" speech system.

Loudspeaker Processors

available in a wide range of channel configurations and cost, from most of the major manufactures

The most popular DSP's for live sound (with the possible exception of FX devices) are known as Loudspeaker Processors (or LPs). These LP units are available in a wide range of channel configurations and cost, from most of the major manufactures of electronics and loudspeakers for live sound.

They typically have a **fixed** configuration, feature set and number of channels. Most LPs are limited to analog I/O, but are programmable through a laptop connection, running soft-ware proprietary to the unit.

pre-programmed for use with same-brand loudspeakers, a short-cut to a quicker system installation

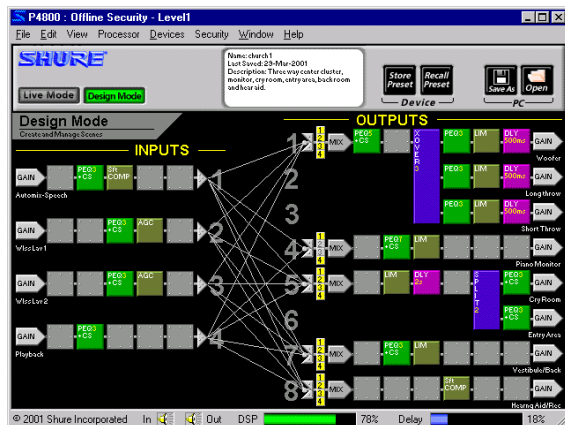
Loudspeaker processors include limiting, EQ, matrix and cross-over functions, but do not offer the auto-mic. mixer and expandable feature of the scalable class of DSP's. Special features include "sense inputs" that monitor signal voltages to the loudspeakers (providing limiting).

Several of these DSP units come pre-programmed for use with same-brand loudspeakers, a very handy short-cut to a quicker system installation. More recently Crown, Crest and QSC have offered basic, low-cost DSP units that mount on the back of their amplifiers.

Be sure that you have a PC handy with the right cable, the software loaded and some training with the products you wish to use. Otherwise, contact a professional that is factory trained to get it setup properly for you. **Be aware that DSP's can be tricky to set-up;** some require that the same system design file loaded in the DSP be saved on the controlling PC, before it can be modified.

Several of these LP's also can be controlled from a very popular and accurate analysis program called SmaartLive, allowing the advanced system tech a more accurate and efficient method to setup the processor. Unfortunately PC-based analyzers are more difficult to use and understand. Remember to establish passwords (some have multiple levels) and to backup or record the settings.

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Shure DSP software