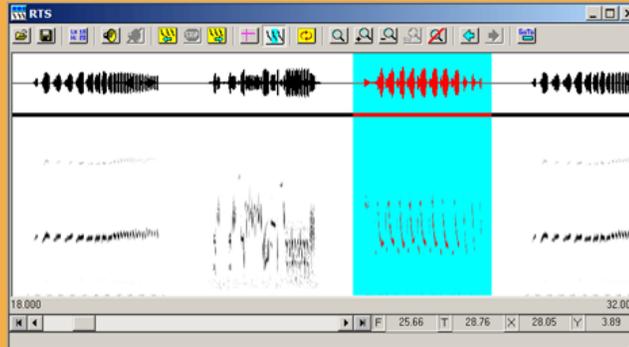


SIGNALtm 5

digital signal analysis system



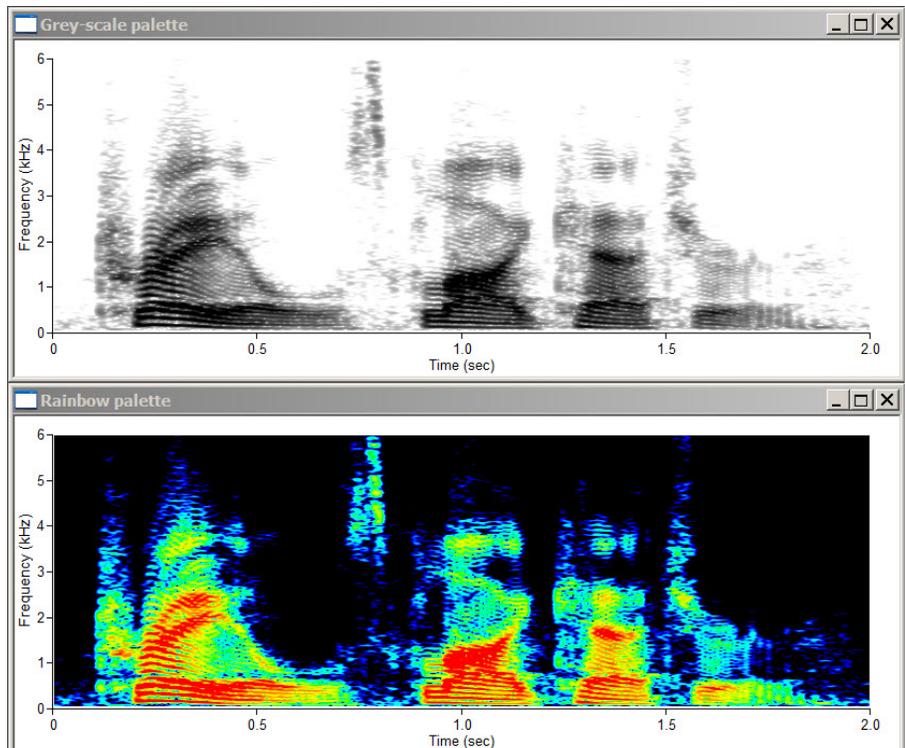
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What's New in SIGNALtm 5

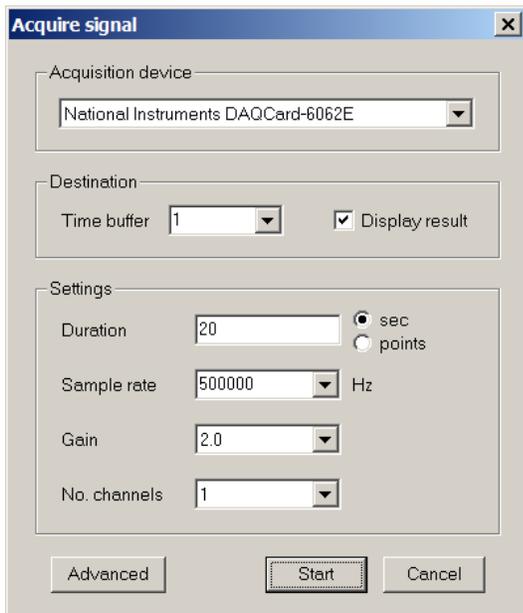
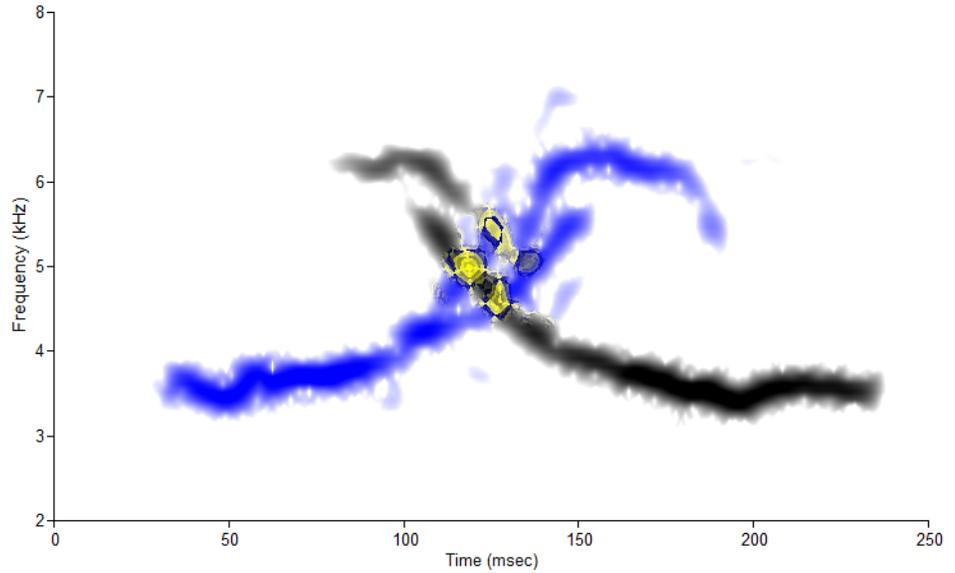
Highlights

Here are some new SIGNAL 5 features...

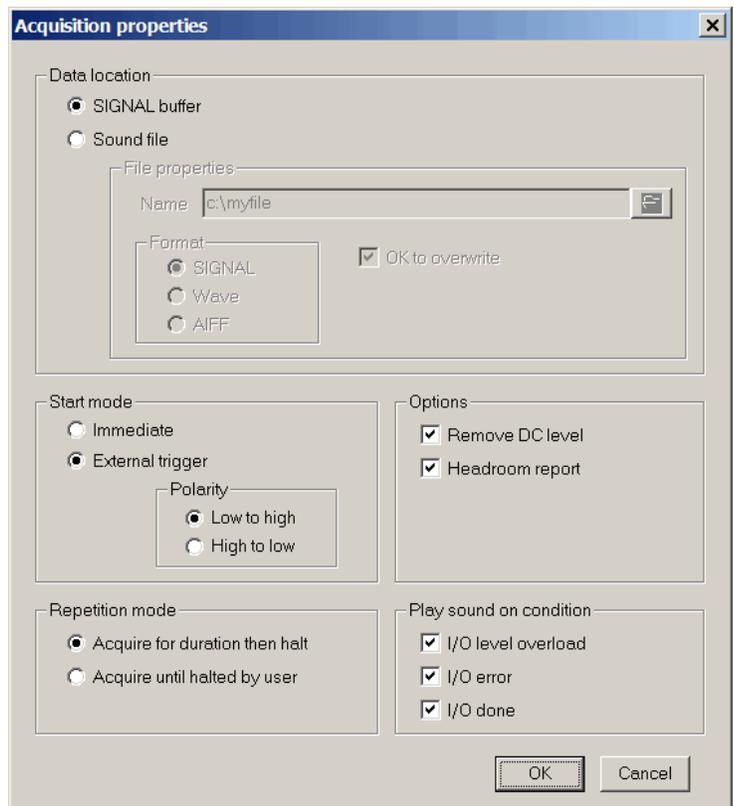
High-resolution spectrogram graphics: draw spectrograms in 256 colors or grey levels. SIGNAL automatically detects monitor capabilities and draws spectrograms at maximum screen resolution for detailed viewing.



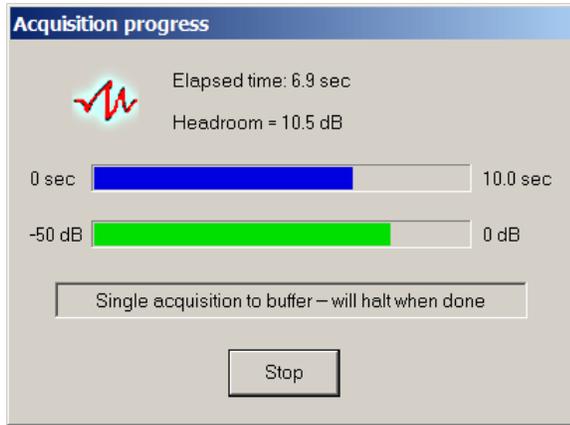
Spectrogram overlays: overlay two FT buffers "transparently", drawing the first spectrogram in greyscale, the second in blue and common content in yellow.



Flexible recording and playback: acquisition and playback can be flexibly and precisely configured for a wide variety of I/O tasks. SIGNAL 5 supports Data Translation, National Instruments and Windows sound cards.

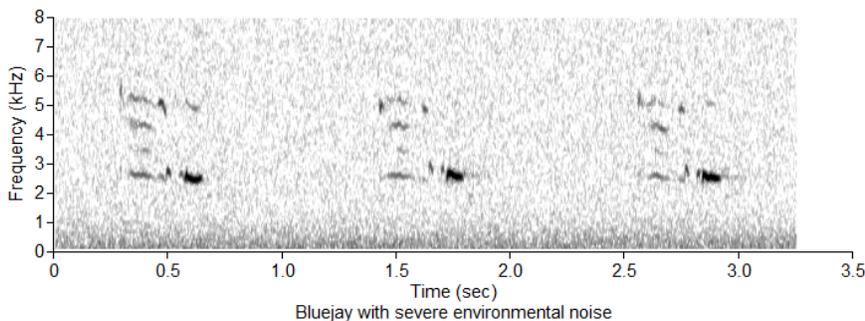
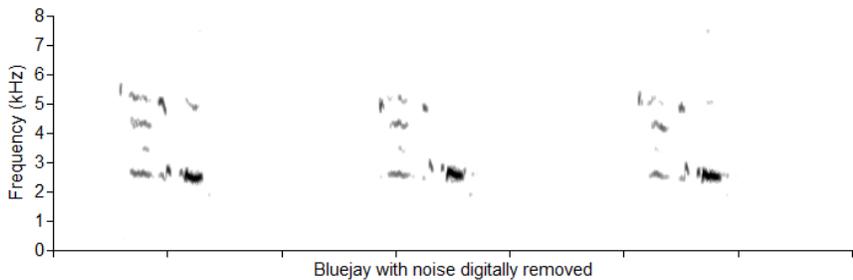
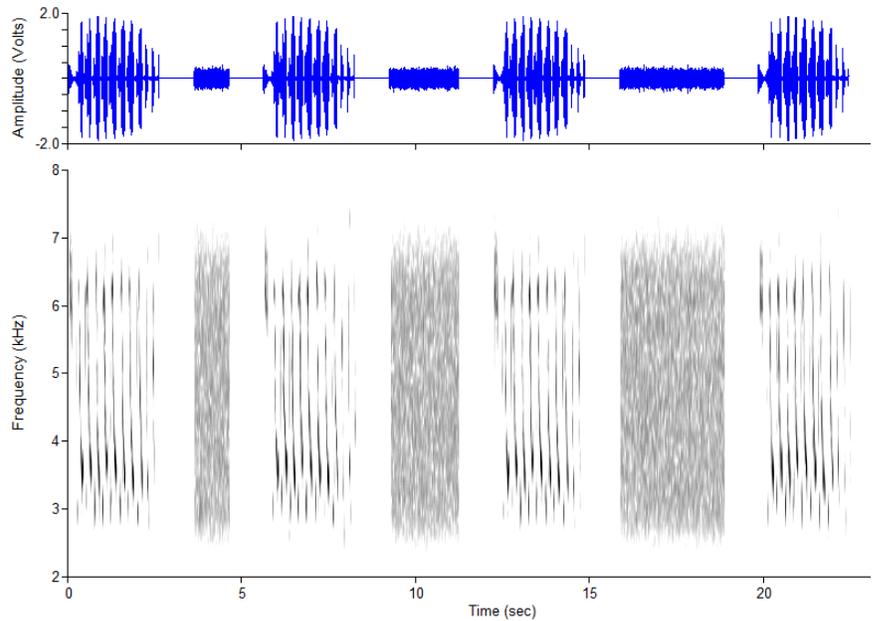


Programmable sound acquisition provides timed, scheduled or continuous recording to memory or disk.



Real-time progress and sound level: acquisition and playback report progress and sound level continuously throughout the I/O process.

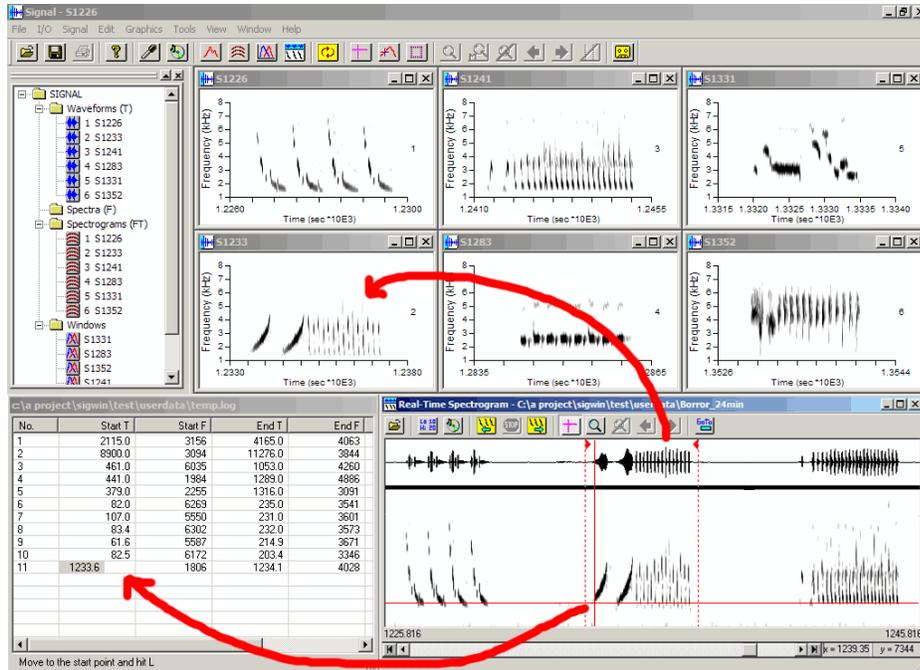
Programmable sound playback allows for stimulus selection, repetition, variation, timing and scheduling. Playback stimuli can be composed on the fly based on random selection, user input, or experimental inputs. These capabilities are further extended by **Experiment Makertm**.



Noise removal: SIGNAL 5 provides a mathematical noise removal technique called **spectral subtraction**, which captures a spectral "noise footprint" from a signal, then removes it from a spectrogram by subtraction. Spectral subtraction can be used to remove noise from signals for use as experimental stimuli.

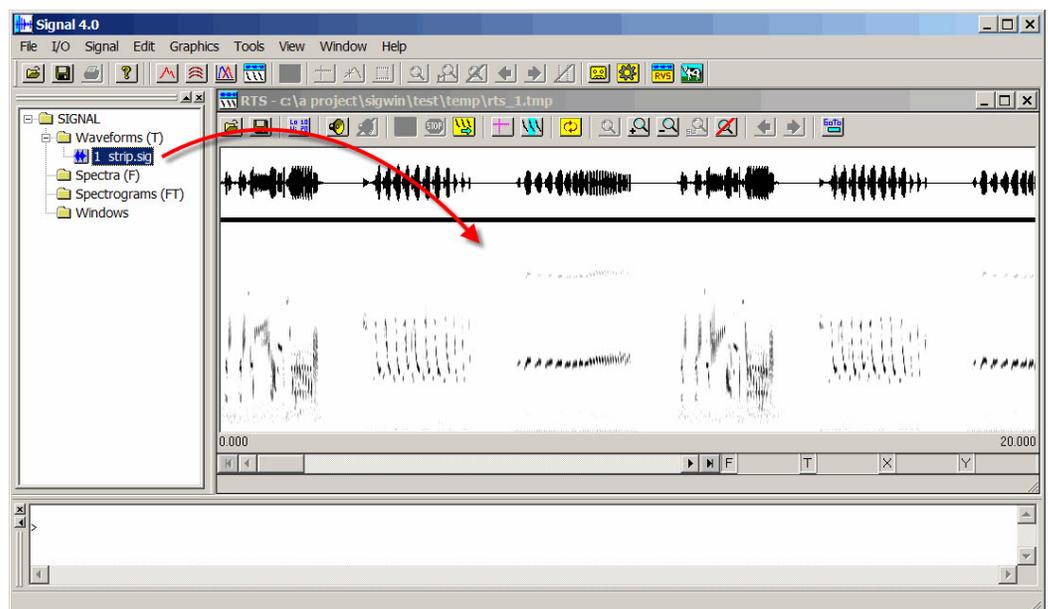
Sound and text file I/O: SIGNAL 5 can read and write 8-, 16- and 24-bit sound files with any number of channels. It can normalize or scale sound amplitude before sound file storage, join sound files or append to existing ones, open an unlimited number of text data files for input and output, and read and write binary data files at byte level for compatibility with any external system.

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SIGNAL/RTS integration: graphics, measurements and signal exchange are integrated between SIGNAL 5 and RTS 5. The RTS can export sound events to SIGNAL for analysis and store screen measurements in the SIGNAL logfile.

SIGNAL 5 can display signal buffers in a scrolling RTS window for scrolling and zooming, and in an unlimited number of floating RTS windows for comparison.



TUTOR is a 30-chapter interactive learning program that teaches all major SIGNAL functionalities by example. TUTOR teaches SIGNAL commands, menus, techniques and the associated bioacoustic theory. TUTOR presents a SIGNAL technique, describes its theory and usage, prompts the user for input, then displays and discusses the results.

XC FT Command
Sound Similarity
Spectrogram Cross-Correlation

SIGNAL Command Help

Help Topics Back Print

XC FT Perform spectrogram correlation

Function: Calculate the normalized cross-correlation of FT buffers *ftbuf1* and *ftbuf2*. Report relative time delay, max correlation, and correlation Q, and load these into UVAR's. The cross-correlation function R(T) is loaded into *tbuf*, if specified. Buffers must match in time duration, time steps, frequency range, freq steps, and FFT length, unless XCCHK is switched OFF.

Before correlation, FT buffers may be amplitude-normalized (depending on the *IN* flags) over a frequency range specified by one of several range flags, using either of two algorithms selected by the CCNORM parameter. Buffers can be XC'd repeatedly for matrix-based event comparison.

Syntax: XC FT *ftbuf1* *ftbuf2* [*tbuf*]

Flags:

Normalization flags:

[no /N flag]	Normalize but leave FT buffers unnormalized
/N	Normalize and leave FT buffers normalized
/NN	Don't normalize

Frequency range flags:

[no flag]	Use entire frequency range
/C	Use cursor frequency range
/Q	Query for frequency range
/R	Use range specified by <u>FE</u> and <u>TF</u>

Output flag:

/O	Display output independent of COMOUT
----	--------------------------------------

Result Vars: UVAR 11 Time delay (msec)
 12 Max correlation value
 13 Q value

Example: >>XC FT 1 2 4 Cross-correlate FT bufs 1 and 2, place the corr function in time buf 4.

Delta-T (ms): -7.50 Corr: .94 Q: .46

The XC FT (Cross-Correlate FT) implements this process. It performs the sliding correlation and produces a time function containing the changing correlation as a function of time slide or offset. XC FT reports the maximum value of this function, which is the similarity of the two matrices.

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Overview
Sound Similarity
Spectrogram Cross-Correlation

Sliding spectrogram cross-correlation: 3 snapshots

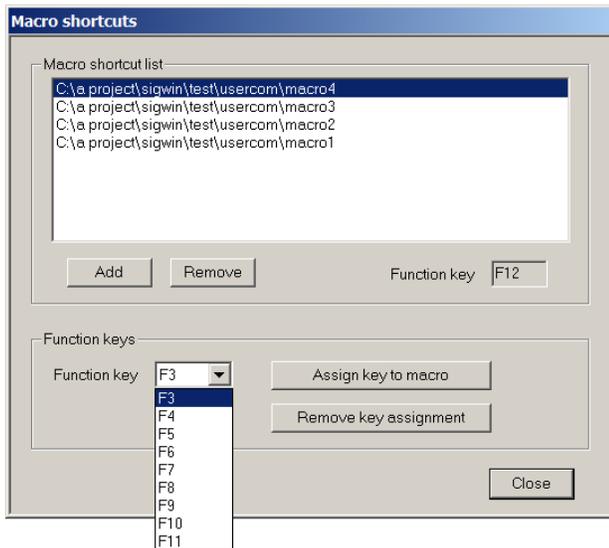
Numerically, a digital spectrogram is a frequency-time matrix in which each cell represents the signal's intensity at a particular frequency and time. SIGNAL compares two digital spectrograms by performing a sequence of two-dimensional (T,F) cross-correlations between the respective matrices.

This sequence of correlations is analogous to sliding two transparencies containing the spectrograms step-wise against each other along the time axis, and measuring the changing congruence or common area. This congruence is scaled to a numerical correlation value between -1 and 1, where 1 represents total similarity, 0 no similarity, and values below 0 represent anti-similarity and are disregarded.

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TUTOR covers:

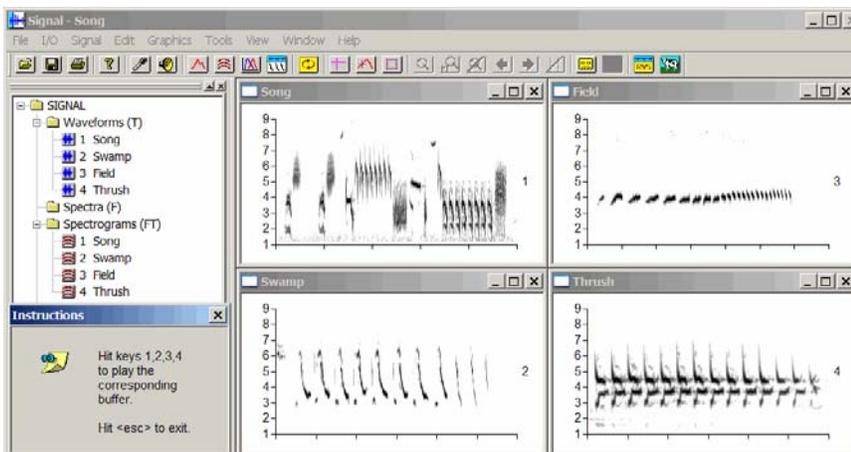
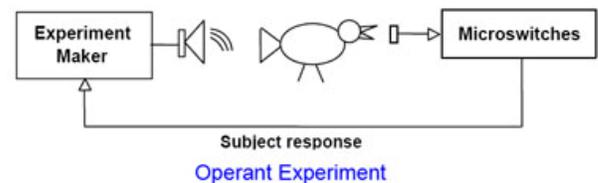
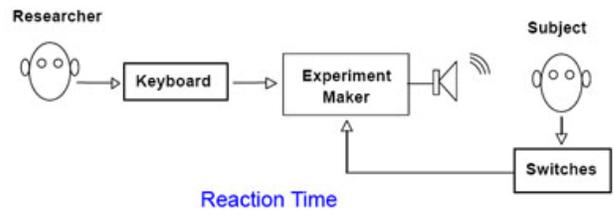
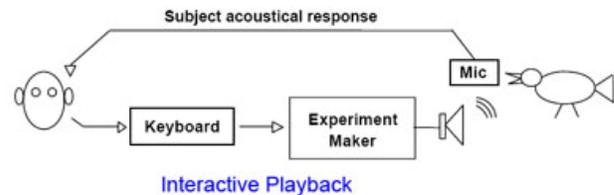
- SIGNAL techniques such as sound acquisition, display, and editing
- bioacoustic analysis principles such as sound sampling, Fourier transforms, and frequency resolution
- advanced research techniques, such as sound similarity; sound synthesis; and analysis of frequency contours.



Usability: SIGNAL window size and location is remembered between sessions. Create a "favorites" list of user-written macros and assign to function keys for quick access. Launch multiple SIGNAL 5 sessions for comparative analyses, or to analyze signals in one session and prepare them for image capture and publication in another.

Experiment Maker™ is an add-on module released with SIGNAL 5, adding simultaneous acquisition and playback, microsecond timing and triggering, digital I/O and keyboard control. Experiment Maker allows the researcher to construct presentation, measurement and control systems that would otherwise require months of programming.

Applications include dynamic stimulus selection, timed playbacks, adaptive playbacks, reaction time and integrated acoustic and visual testing. Playback stimuli can be constructed and selected in real-time, based on any combination of stored stimuli, random selection, user input, subject responses and experimental conditions and triggers. Stimulus choice, subject response, and experimental conditions can be logged for later analysis.



Experiment Maker can perform keyboard-controlled playback. The keyboard might be controlled by the researcher for interactive stimulus selection or by the subject for recognition and reaction time studies. A new Gaussian random signal generator provides statistical stimulus selection as well as noise signal synthesis.

Engineering Design

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