

## Tech Brief: Roland SuperNATURAL and Behavior Modeling

Roland's proprietary SuperNATURAL® modeling technology delivers a quantum leap in realism in both sound and expression when digitally emulating traditional instruments. First introduced in 2008 with the ARX Expansion Boards for the Fantom-G, SuperNATURAL technology has appeared in more recent Roland products including the Music Atelier® AT-series organs, the RD-700GX and HP-307 digital pianos, and the AX-Synth® shoulder synthesizer. Debuting in 2011, the Roland JUPITER-80 is the first synthesizer based entirely on SuperNATURAL sound engines. Moving forward, SuperNATURAL is the foundational technology upon which Roland will base many of its next-gen instruments.

**Historical Perspective.** For decades before the advent of SuperNATURAL, the industry standard for reproducing the sound of traditional instruments has been PCM sampling. The challenge with sampling is that most acoustic instruments respond differently depending upon how hard they are struck, blown, bowed or otherwise energized by the player. (As a simple example, most acoustic instruments grow brighter as they get louder.) Recording a sample of an instrument played with a given amount of force, however, captures and delivers only that one-dimensional rendition of the sound.

In attempts to mitigate this, manufacturers have employed workarounds such as using velocity-driven filters in conjunction with bright samples. More sophisticated technology uses multiple samples of a given note at multiple energy levels—then maps those samples to different velocity ranges where they are “velocity switched” during performance according to the amount of force exerted by the player. Additional sample-related workarounds include memory conservation when emulating long decays by applying an envelope to a looped portion of the sample.

In even the most sophisticated implementations, this technology is far from perfect. The piano is the quintessential challenge for a variety of reasons including dramatic dynamic range, extreme pitch range, exceptionally long decay times and the sympathetic resonance of all the components of the entire instrument—to name just a few. Even attempts to digitally reproduce the piano with gigabytes of multiple samples fall short in realism, expressiveness and flexibility.

The wide range of performance articulations inherent in many instruments further complicates realistic use of sampling technology. Orchestral string players, for example, employ a variety of bowing styles. With traditional sample-based instruments, an array of samples for each of these styles must be captured distinctly from the other styles and typically assembled into entirely separate sets. To alternate between legato and staccato violins, for example, the player of a sample-based keyboard would have to switch patches, play different keyboard zones or develop a unique playing style to accommodate different sets on different velocity layers.

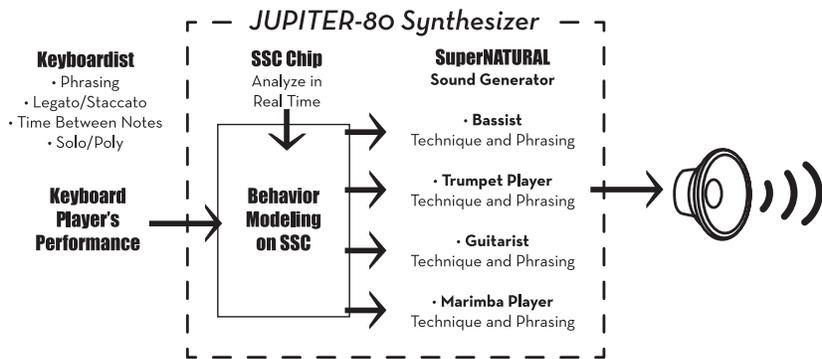
**Enter SuperNATURAL Technology.** Roland's revolutionary SuperNATURAL technology adds powerful sound modeling to the equation. Each SuperNATURAL instrument—piano, violin, trumpet, etc.—has its own specialized engine. That's because, just as the sounds of a piano, flute and tympani are very different, so are the attendant modeling needs.

Each SuperNATURAL engine is indeed based on top-quality studio samples of the original instrument, however that's where the similarities to PCM-based gear stop. For starters, SuperNATURAL does not employ sample looping—resulting in smooth, organic decays. Moreover, Roland engineers developed technology that creates models of the formative characteristics and responsive aspects of each instrument. The SuperNATURAL engine transparently handles how those parameters react to performance dynamics and nuances from a controller such as a keyboard—just as they would in the original instrument.

As a simple example, volume and brightness in SuperNATURAL instruments respond to nuances in playing force smoothly as pure, natural sounding/feeling articulation—without any velocity switching and inherent stepping sounds between sample layers. SuperNATURAL goes much deeper, however. Looking at the orchestral strings scenario mentioned earlier, SuperNATURAL modeling translates the keyboardist's natural use of playing styles such as legato and staccato into appropriate variations in bowing technique and associated sound. Further, use of a pedal or switch seamlessly invokes tremolo or pizzicato styles.

SuperNATURAL technology is designed to be transparent for a natural playing experience that requires no thinking, programming or changes to playing style. For users who do wish to dive deeper, most SuperNATURAL instrument engines do provide some modicum of access to key parameters such as how much growl and noise brass instruments have. In perhaps the most sophisticated example, the SuperNATURAL piano engine in the JUPITER-80 allows players to easily adjust the desired amount of string resonance, key-off noise, hammer noise, stereo width, tonal character and more. These continuously variable modeled characteristics in SuperNATURAL engines are a sharp contrast to what are largely snapshots of timbres in electronic instruments relying solely on samples. The upshot is a distinct leap in realism with respect to both sound and responsiveness.

**New Behavior Modeling Technology.** Where SuperNATURAL technology models the natural sound qualities and expressiveness of traditional instruments, Roland's groundbreaking new Behavior Modeling technology goes a step further by intelligently recreating on demand the articulations that happen when those instruments are in the hands of seasoned players. Behavior Modeling acts as an interpreter between a keyboard player's phrasing and the performance technique/phrasing associated with the original instrument.



As a simple example, when a trumpet player performs a half-valve trill, the initial transient attacks inherent in playing isolated single notes are absent. Behavior Modeling not only reproduces that sound authentically, it integrates it into the SuperNATURAL trumpet engine so that a keyboard player can invoke those trills faithfully using a natural, intuitive playing style.

Continuing the trumpet example: A trumpet rip results in a multi-octave glissando through a series of discrete pitch breaks. Grab the pitch bend controller while playing a SuperNATURAL trumpet and you get exactly that rather than a traditional smooth synth pitch bend.

Various SuperNATURAL instrument engines feature Behavior Modeling articulations inherent to their namesake instruments. Guitar-specific techniques such as strumming, hammer-ons, pull-offs and grace glides are part of the Behavior Modeling found in SuperNATURAL guitar engines. For tympani, the pitch bend controller brings in rolls and the D Beam dynamically mutes the membrane. With marimba, the pitch bend controller yields authentic glissando and pedaling introduces alternating trills just like the real thing. These and many other Behavior Modeling implementations across SuperNATURAL sound engines allow keyboardists to easily and authentically emulate the performance articulations of a wide variety of traditional instrumentalists.

**Summary.** Going far beyond traditional sampling technology, Roland's proprietary SuperNATURAL sound engines incorporate instrument-specific modeling to deliver authentic sonic and performance realism for many different types of instrument categories spanning acoustic, electric, orchestral and ethnic. New Behavior Modeling technology gives musicians the added ability to easily emulate the performance articulations employed by expert players of traditional instruments. These complementary technologies are fully realized throughout the JUPITER-80 live performance synth and form the bedrock for many Roland products in the future.