FM-X Development Story

Taking a Closer Look at the Appeal of the MONTAGE's FM-X Sound Engine

The MONTAGE features never-before-seen specs, including the FM-X—a state-of-the-art eight-operator, 88-algorithm, 128-note polyphonic FM sound engine. The technology that forms what could be deemed the cornerstone of FM-X tone generation actually goes back to the 1980s. In the first part of this article, we will talk about what went on behind the scenes in the development of the MONTAGE’s FM-X sound engine. In the last half, we will delve into why FM-X synthesis is so appealing, featuring a talk between Katsunori Ujiie, who was involved in the creation of many of the preset sounds found on the MONTAGE, and Shinichi Ohta, the producer in charge of MONTAGE development.

1. Various experiments with FM synthesis
2. The development of a new FM sound engine
3. The birth of the MONTAGE and FM-X
4. What’s appealing about FM-X?—a dialogue with Katsunori Ujiie and the developer of the MONTAGE
Various experiments with FM synthesis

Research on FM synthesis at Yamaha began in 1975, and bore fruit in the GS1 synthesizer released in 1981. Although the GS1 was the Yamaha’s first electronic instrument to feature an FM sound engine, it was really the DX7 released in 1983 that really brought FM synthesis to the world. A synthesizer with an onboard FM sound engine, the DX7 was an incomparable hit; the DX series sold a total of 420,000 units, and is widely known as the series that bought the sound of FM global recognition. Although the story of how the DX7 was developed has been covered in various articles and books such as 2015’s “The History of Yamaha Synthesizers,” and so will not be discussed here, we will mention the prototype that led directly to the DX series, the “PAMS (Programmable Algorithm Music Synthesizer).” The words “DIGITAL PROGRAMMABLE ALGORITHM SYNTHESIZER” printed on the DX7 itself serve as testament to the fact it has inherited the original concept of the PAMS, and indeed, the core sound concept of the PAMS lives on in the MONTAGE, more than thirty years later.

Released in 1986, the DX7II was brought even greater musical expression to the DX line, featuring a new LSI with a higher-resolution sound engine, dual mode, panning, micro-tuning and more. Also worthy of note were its aluminum body, intended to make the instrument more lightweight and portable, and the 3.5" floppy disk drive (these disks were easily obtained at that time).

The release of a string of FM synthesizers, together with the feedback received from both professional and amateur musicians, put us in a position where we were able to review the characteristics of the FM sound engine. Below are the strong and weak points of FM synthesis.

Sounds that the DX7 (FM) did well:
• Percussion instruments, bowed string instruments, brass/wind instruments

Sounds that the DX7 (FM) did not do well:
• Acoustic pianos, noise sounds, lingering sounds that changed over time, human vocals

The question of how to overcome the deficiencies in FM synthesis has been a major issue with FM since the release of the DX7II. Moreover, changing times brought sampling (PCM synthesis) to the fore in sound generation, and the quest to offer more freedom in sound creation, and to establish the superiority of FM as a sound
Points 1–3 above simply enhance the creative potential and freedom of sound creation with an FM synthesizer; whereas point 4 was intended to overcome limitations in noise control. Point 5 really did not garner any significant results in terms of practicality, since combining AWM2 and AFM sounds usually just produced noise effects. This was partly because there were not many preset sounds that made good use of the characteristics of the RCM tone generator.

1 Various experiments with FM synthesis

A research lab at Yamaha during development

2 The development of a new FM sound engine

In 1988, Yamaha began in-house development of a new FM sound generation system in parallel with work on the AFM sound engine. This new system was the PAMS2, an evolved version of the PAMS that had been the prototype for the DX series. The goal of this project was to create the sounds that the DX7 was unable to properly recreate, such as sounds with noise components, lingering sounds that changed over time, and human vocals. PAMS2 used FM and Formant as sound synthesis methods, with Formant later being developed into a new technology that synthesized human vocals in real time using the PLG100-SG ("singing board") plug-in board. Here, we will take a look at the FM sound engine section.

PAMS2 introduced more algorithms (88) as well as more operators (8) in order to synthesize the sounds that the DX7 was not good at producing (mentioned previously). The idea of expanding the algorithms into "programmable algorithms" was the natural progression of the move towards synthesizing more complex sounds. Further, by making other waveforms besides sine waves selectable as operators, as well as allowing the harmonic structure to be modified using parameters, instruments such as the TX81Z and the SY77 were able to offer a vast range of output waveforms for the operators.

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already been conceived a quarter of a century ago, at the end of the 1980s. However, the road leading to the creation of a viable product was long.

The FSP1 prototype was completed in 1992. Although a huge number of breadboards were needed by the development team when they first started working, the three-chip structure of the newly-developed sound LSI allowed the components to become so compact that they fit into a 2U-sized sound module. Although the sound engine was shaped like a module, from the outset various efforts were made towards the expression of sound using controllers and user interfaces. One of these efforts was the Editor software for Macintosh, which was an X-Y-Z touch panel-type controller. To bring the prototype closer to a finished product, musicians were called in over and over again to critique the sound and playability, and in 1996 Yamaha finally integrated these sound generation systems into a single LSI chip.

However this was a time in which sampling (PCM) sound generation was at the height of its popularity, and virtual analog synthesizers were just beginning to come onto the scene, pushing FM synthesis out of the spotlight for a while. To add to this, the mid-1990s was the most trying period in history for Yamaha synthesizers. Yamaha had many products on the drawing board besides the FSP1 and struggled to find a way out of these difficulties, but was unable to find a breakthrough strategy. Things began to change with the release of the FS1R in 1998. Development began with the completion of the new sound generator LSI, the FS1, leading to the development of PAMS2 in 1998 making this a product that spanned a decade in development. As a sound engine, it had potential; and the fact that it offered extensive possibilities for creating sound was unquestionable. Unfortunately, the main unit used the MU90R and MU100R DTM sound engines due to cost restrictions, which made the user interface far less than ideal, and prevented the potential of the unit as a sound engine from being fully exploited. As a “dark horse” amongst synthesizers, the FS1R won positive critical acclaim, but it did not gain wide popularity amongst musicians at large.
The four generations of Yamaha synthesizers in the MOTIF series that followed the DX7 showed significant evolution, including the initial model, the ES, XS, and the XF. The evolution of the MOTIF series has come alongside developments in the sound generator LSI, with the LSIs found in each model released being state-of-the-art for their time. It was the completion of next-generation sound generator LSIs that was at the background of the birth of the MONTAGE.

The state-of-the-art sound generator LSIs found in the MONTAGE support AWM2 tone generators with further improvement in sound quality, and feature an FM sound engine at their core. Owing to this they offer stable performance when used under FM-X sound engine specifications, without being unduly affected by the usage status of the AWM2 sound engine, the effects, or the processing load. Also, as with the AWM2 sound engine, the new FM-X can make use of the MONTAGE’s powerful filters and effects, realizing 128-note polyphony that can handle any kind of playing situation.

To add to this, the resolution for the EG of each operator has been enhanced in anticipation of using the MONTAGE’s new sound generation system (FM-X) together with the Motion Control Synthesis Engine. This allows for smooth control of the OP levels on the EG, resulting in a higher fidelity sound. With all of this, the FM-X sound engine offers widely-varying sound, from standard sounds to new-generation FM sounds, making possible a wealth of sonic expressiveness not available using AWM2 synthesis.

The major advantages of FM-X synthesis are shown below.

- High base specifications specs, including eight operators, 88 algorithms, and 128-note polyphony
- Waveforms can be selected for the output waveform of operators, and parameters used to change harmonic structure, allowing the creation of a vast range of operator waveforms
- FM-X can be freely layered with the AWM2 sound engine, making it possible to apply powerful filters and effects as with the AWM2 sound engine
- Higher EG resolution for each operator allows for smooth control of the OP levels for each EG, resulting in a higher fidelity sound

FM-X is truly the FM synthesis of today.
4 What's appealing about FM-X?—a dialogue with Katsunori Ujiie and the developer of the MONTAGE

Ujiie: We worked with different ways of combining PCM and FM synthesis on the SY77 and the SY99. With the DX, FM had already reached a considerable level of sound-making completeness in terms of analyzing and recreating sounds; PCM still wasn’t up to the level we wanted. Back then, FM was the driving technology that we used to supplement the weaknesses of PCM when making sounds. Now with the MONTAGE, both FM and PCM have really grown into something massive. It’s a totally different dimension from what we had with the SY77 and SY99. Also, although FM is set up very
differently on the MONTAGE compared to the DX7, it felt completely familiar to me.

**Ohta:** That’s because the DX algorithms are all included in the MONTAGE, and there are 88 algorithm types. Compared with FM synthesis on the DX7, there are many different parameters besides sine waves, and you can use multiple parameters to do parametric changes to the frequency characteristics. When you multiply all of these, you’ve got quite a lot of variations in waveform (laughs).

**Ohta:** What was the most interesting thing about working with the MONTAGE?

**Ujiie:** Well, if you multiply too many FM sounds, you just get strange noises, right? Individually, you can’t really use these sounds as anything but noise; but by applying continuous changes, you might be able to create piano or strings, or even a brass sound. That was something that I found fascinating. You can take it in all sorts of directions, and it’s great fun to experiment. It’s almost shocking to work with FM like this. If you’ve had a taste of how fun it is to use four-operator FM synthesis with the reface DX, you’ll be blown away when you bring out the MONTAGE.

**Ohta:** Especially since you’re controlling all those parameters with the control box! That kind of continuous change in sound really showcases the appeal of Motion Control. I’m so happy to see that.

**Ujiie:** People are going to look at this and wonder what on earth the player is doing!

**Ohta:** I’m pulling out the whole bag of tricks, so they’re going to go nuts just checking out the preset sounds (laughs).

**Ujiie:** Motion Sequences are really alive, in and of themselves. I think playing this keyboard with the motion sequences is really great for bringing life to the music.

**Ohta:** There are two ways to approach this MONTAGE. You can use a Motion Sequence itself to control the parameters, or you can use Motion Sequences for automated control. I think it’s interesting how you can use either approach, and how the way the MONTAGE is used really depends on the person.

**Ujiie:** Some people like using the Super Knob for real-time control, and other people will like using it to enjoy making changes to the sound, right. It can be pretty fun to use the knob to change the frequency, although it depends on the range. You can really tend to go way out there with this thing.

**Ohta:** Like when you assign the knob to multiple operators, and move them all with different curves?

**Ujiie:** It gets to be a real blast when you couple rate with time, using the knob. There’s really so much you can do with it, isn’t there?

**Ohta:** The resolution has been enhanced compared with FM in the past, which has given us a boost in the quality of synthesis. That said, the key assigner has become more intelligent; so the CPU load can be controlled more effectively and dynamically than before, according to the number of notes sounded.

**Ujiie:** I’d been banging out the notes when making the sounds, and I really hadn’t noticed the change. Since I didn’t notice anything strange about it, it must be working pretty great. When you think about it, 128-note polyphony is the same as the specs of the TX816, right... but that cost ¥890,000 back in the day, didn’t it? The MONTAGE has those specs, plus sampled sounds... man, what a monster this is!

**Ohta:** So, what are your impressions on the sounds the MONTAGE makes?

**Ujiie:** This synth is the real thing! It’s a great match with FM, and it’s got the speed I need. It’s got the basics down, being at that orthodox Yamaha level that’s such a huge step above the rest, including the playing feel. FM synthesis gives you such overwhelming freedom. For instance, I made this layered sound with a CFX piano and an FM electric piano at its best, which will blow you away! You’re really getting across the feeling of playing a musical instrument, right.
**Ohta:** Could you give us your honest opinions on what it was like to produce the sounds for the MONTAGE?

**Ujiie:** I feel that the way we approached the sound-making this time was fabulous. A good sonic sense is important. Peter was the kind of guy who gave us these sounds that just blew us away, saying “What the heck is this?” I also thought that Scott gave us a bunch of sounds that settled us down, while Martin offered some very nice sounds, from the orthodox to the wild. I think there are still a lot of possibilities to explore. I’d go so far as to say that we’ve only scratched about 30% of what the MONTAGE can really do. If we’d taken it right to the limit, people would probably say, “Oh, is that all?” which would make this all meaningless. I’m really looking forward to the future with this synth, knowing that it’s still got a lot of potential to create so many sounds that no one’s ever heard.

**Ohta:** Last question. What do you feel is so appealing about FM-X?

**Ujiie:** It’s the grand vision I had from the time of the DX7, which was “how to create a continuous sound.” People will see it as sensational that you can at last control the FM parameters in an analog way. Looking at it this way, Yamaha’s decision to go with the FM route over analog was right on target. Putting Motion Control and FM-X together gives you an impact that’s even better than a real analog synth.