PUSH TURN MOVE

INTERFACE DESIGN IN ELECTRONIC MUSIC

EDITED BY
MIKE METLAY & PAUL NAGI F
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FRAMEWORK

Electronic instruments emerge in the mysterious space between innovators and musicians, driven by the ongoing march of technology and the visions of those at its leading edge. The designs are based on core principles, solving technological paradoxes, cultural trends, traditions, desires and imagination. The following model sets out the framework for the book and for exploring, understanding and studying the world of electronic instruments and their many karmas.

USER
Electronic instruments seldom make sound without a human initiating an action or a process somewhere. As users, we tap on pads, press buttons or twist knobs to generate, route or modify the sound. While doing this, we are engaged in a focused or explorative workflow, whether playing on stage or in the studio, in a collaborative situation or alone, and we react to feedback from our actions - whether visual or audible. We do, see, hear - and do again.

This human-machine interaction can be quantifiably successful, annoyingly stressful, or qualitatively joyful. It depends on our experience, efforts and results with a given device. User experiences are thus also dependent on a range of factors such as situation, skill level, and understanding.

SOUND
Electronic music starts with sound. Listening to sound is important when working with it, but visualization of sound adds a new dimension and supports further understanding. This can aid the generation, routing or modification of the sound while interacting with an electronic instrument.

Visualizing sound on an instrument, in a software interface, or in an app, can always be accomplished in countless ways. However, there are some commonly used methods to help the user perform tasks across a variety of products and/or interfaces. These can include everything from reaching out for the sustain knob on a synthesizer to filtering out certain frequencies in a mix, adjusting the velocity or scale of notes on a sequencer, or beat matching songs in a live DJ performance.

CONTROL
Sound is controlled by either being set or generated, routed (patched somewhere), or modified. Whether it's a full track played, mixed and affected by a DJ, or a waveform being modulated, filtered and routed in a modular synthesis system, the three main functions of controlling sound are: Generation, Routing, and Modifying.

To control sound we need to interact with it. Traditional techniques include adding vibrato to a string on an electric guitar or playing with a soft attack on a drum machine. Commonly applied to synthesis, which employs knobs, faders, modulation wheels, buttons and many other types of control. This section examines the many control elements that directly connect the user to the sound being made.

LAYOUT
The controls available on an electronic music device are laid out according to certain design principles that have evolved over many decades. These principles guide the user with respect to the function and relevance of the controls.

Whether on a hardware synthesizer, DJ mixer, Eurorack module or a music app, these principles differ from the way we perceive elements and objects in our environment. We ask: What is nearby? What should be grouped together? What is important?

Applying these ideas requires a mix of spatial rules, ergonomic considerations, design traditions, and a wide variety of interface factors: visual and tactile feedback, legibility, familiarity, color, consistency, grouping, and more.

CONCEPT
Historically, electronic instruments have inspired a diverse spread of interface concepts. This chapter explores how these are realized in different software and hardware platforms.

Here we look beyond traditional categories such as drum machines, synthesizers, sequencers, etc., instead, we will consider the ideas that drive contemporary electronic music making, drawing attention to commonly shared principles and interesting approaches.

TIME
Our experience of either material or time is often mediated by the physicality of a device that the user can see and touch. As technology becomes more ubiquitous, we take more for granted. However, the essence of any musical instrument is that it can be played, at least in some way. When we play with a synthesizer, a computer, or a hard drive, we are following a timeline that is gradually changing from the simple to the complex. Eventually, we will come to a point where all the elements of our experienced music are present in some form. At this point, we will be able to do both at once.
SCOPE

The scope of this chapter is to explore the relationship between musical instruments and their digital counterparts. We will focus on the design principles, control interfaces, and the user experience of these digital instruments.

SOUND

Electronic music starts with sound. Listening to sound is important when working with it, but visualization of sound adds a new dimension and supports further understanding. This can aid the generation, routing, or modification of the sound while interacting with an electronic instrument.

Visualizing sound on an instrument, in a software interface, or in an app can be accomplished in countless ways. However, there are some commonly used methods to help the user perform tasks across a variety of products and for interfaces. These can include everything from reaching out for the sustain knob on a synthesizer to filtering out certain frequencies in a mix, adjusting the velocity or scale of notes on a sequencer, or beat-matching songs in a live DJ performance.

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Sound is controlled by either being set or generated, routed, patched, or modified. Whether it's a full track played, mixed, and affected by a DJ, or a waveform being modulated, filtered, and routed in a modular synthesis system, the three main functions of controlling sound are: Generation, Routing, and Modifying.

To control sound, we need to interact with it. Traditional techniques like adding vibrato to a string on an electric guitar or playing with a soft attack are commonly applied to synthesis, which employs knobs, faders, modulation wheels, buttons, and many other types of control. This section examines the many control elements that directly connect the user to the sounds being made.

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The controls available on an electronic music device are laid out according to certain design principles that have evolved over many decades. These principles guide the user with respect to the function and relevance of the controls.

Whether on a hardware synthesizer, DJ mixer, Eurorack module, or a music app, these principles derive from the way we perceive elements and objects in our environment. We ask: What is nearby? What should be grouped together? What is important?

Applying these ideas requires a mix of gestural rules, ergonomic considerations, design traditions, and a wide variety of interface factors: visual and tactile feedback, legibility, familiarity, color, consistency, grouping, and more.

CONCEPT

Conceptually, electronic instruments have inspired a diverse spread of interface concepts. This chapter explores how these are realized in different software and hardware platforms.

Here we look beyond traditional categories such as drum machines, synthesizers, sequencers, etc. Instead, we'll consider the ideas that drive contemporary electronic music making, drawing attention to commonly shared principles and interesting approaches.

TIME

Our experience as either maker or user is widely colored by the time we live in and therefore the technology that is currently available—in and already established. How we use instruments and devices changes over time, as does technology, production methods, availability, aesthetics, and style. The swipe on an iPad is today as natural an interaction for most musicians as sliding a fader or pressing a key. To put things into perspective, we look at some significant devices that defined or challenged previous and contemporary ways of interacting with electronic music and managed to do both at once.
RUMEN CATEGORIES

Workstation
A workstation usually contains a combination of several categories. As an example, it could be a synthesizer, sequencer, recorder, drum machine, and mixer. A self-contained workstation can be either a dedicated piece of hardware like the one shown above, or a unified software environment. By its nature, a workstation is capable of performing many duties, from musical sketch pad to final production platform.

Sampler
A sampler is a dedicated audio recorder designed to capture and play back audio in alternative ways. Mostly, the purpose is to arrange or rearrange source material to construct new music or to create a new instrument based on sounds or loops of individual notes. Detailed control of elements such as pitch, looping, shaping and even sequencing and granular processing may be involved.

Sequencer
Sequencers are the core basis of music — a linear process with a start and an end. When sequencing, we input notes or events, either manually or by activating steps on a grid. A dedicated standalone sequencer newly includes sound sources, its most important role is to keep your other gear busy! Sequencers are sometimes built into synthesizers and are an inevitable component of drum machines, but can also be found on sampling and effects units.

Mixer
The basic function of a mixer is to allow the user to route several audiosources to appropriate destinations in the audio chain, to make a balanced and coherent mix of them. In this process, it’s important not only to be able to adjust individual channels of audio, but also add effects, combine them into groups, and process them separately or collectively.

Acoustic inspired
Electronic instruments looking and acting like their acoustic counterparts or mimicking their visual characteristics or playing surfaces. From the electric guitar, MIDI wind controllers, electronic maracas, and violin to electronic drum kits and much more. Though there are very different interfaces in this category, they have one essential thing in common, and that is to provide a familiar playing style on a somewhat known instrument surface, possibly with expanded features.

Effect
Effects may exist as independent hardware or software devices, or may appear as part of mixers, synthesizers, etc. Their task is to process audio input and send the processed audio to another device. When using the effect, the user should be able to conveniently route audio to the effect, adjust settings and parameters, and output the result. Mixing the effect with the original audio source and modulating effects parameters are also common functions. The distinction between synthesis and effects is often blurred, but for convenience we think of an effect as processing the final sound output (e.g. reverb, delay) while synthesis typically occurs ‘in line’ (e.g. ring modulation, filtering).

Drum machine
The core duty for a drum machine is to provide a beat. This is accomplished with an internal sequencer, and usually some sort of musical division is apparent in the form of steps or pads. Typical tasks on a drum machine are the selecting and perhaps tweaking of sounds, the placement of triggers with musical measures, recording, playing and editing patterns of notes. Examples of drum machines range from software and small handheld devices to larger desktop units with sampling options (molecular systems). Where drum sounds can be played on the keyboard and sequenced like any other musical note event. Effects, filters, modulation and the like also frequently appear on drum machines.

Recorder
The recording of audio in some form or another — whether analog and digital. The core task here is to record something and be able to play it back, whether whole performances or for publishing. Field recordings or careful recording of a piano for reproduction in a software sampler. When recording we want to control transient and levels — but also handle the recording with actions such as saving, loading, deleting and the like. We may also wish to loop pieces of audio, process them, or slice them into smaller units for use in samplers.

Stage piano/keyboard
Stage pianos are relatively simple keyboards with quick access to the common piano, organ and maybe synth sounds that are considered usable in a variety of musical settings. The primary objective with the interface design of an instrument in this category is to give the user: fast access to the most-used sounds and provide the expected controls over them. Front panels on this kind of instrument might be simple and free from visual ‘noise’ to allow fast orientation in a performance situation.

Controller
The controller category is diverse and includes everything from mixer-like interfaces to MIDI keyboards, grid controllers, drum controllers, etc. Members of this category don’t generate sound themselves and are usually highly configurable to cope with a range of hardware or software. The essential duties of a controller are (besides controlling, obviously) to provide detailed configuration options and offer flexibility. A controller may be either very generic or specifically targeted towards a single duty (for example DJing).
INTERFACE TYPES

Electronic instruments have more facades than a diamond, and more shapes than a jellyfish. They gazelle at us from iPod apps, self-built devices, massive modular systems and wireless keyboards and soft. Within the same instrument category there can be huge differences, yet across categories there are often surprising similarities.

An interface can include visual elements like displays, text, colors and graphics; physical elements like knobs, buttons, and faders; or as abstract as computer code or a motion sensing system.

Throughout this book, we will explore the many technological and visual approaches to interfacing with electronic instruments, and though there are many different concepts, we can start by grouping interfaces into these four overall types.

Tangible
Tangible interfaces are 3-dimensional and feature physical control objects like knobs, faders, buttons, keys, etc. and the like. One of the advantages of a physical interface is that the user does not have to look at the control being used, but can simply feel their way across, say, a set of synthesizer keys. It is the most widespread method of interacting with electronic instruments.

The Sequential Circuits Pro-One vintage synthesizer is a typical example of a highly tangible interface. It relies on the user grabbing controls, turning knobs, pushing buttons, and pressing the keys.

Touch-Based
Touch interfaces are based on the user touching a flat surface. This surface can be more or less sensitive to factors such as the number of touch points (fingers), the amount of pressure or the movements performed on the surface.

Touch-based interfaces are dependent on touchstrips, capacitive touch sensing surfaces or multitouch screens. Screens may be built into products or may represent the whole product, as in tablets for example. Such interfaces have many forms.

This is the ROLI Lightpad Block, which is a touch-based interface that's able to detect multiple touch nuances on its flexible but firm surface.

Graphical
The graphical software's aesthetic appeal is represented by a grid. Though graphical interfaces are a board, multiple widgets exist, such as a VOX. Text, graphics and interactive interfaces are digital backdrops, but they may not exist as a VOX.

Seamless
Seamless interfaces are a physical prototype that are controlled digitally, types exist in the form of VIs or sensors. One of the interfaces is an accelerometer, which can track pitch, the other is a Theremin.
FACE TYPES

Touch-based
Touch interfaces are based on the user touching a flat surface. This surface can be more or less sensitive to factors such as the number of touch points (fingers), the amount of pressure or the movements performed on the surface.

Touch-based interfaces are dependent on touchmats, capacitive touch sensing surfaces or multitouch screens. Sensors may be built into products or may represent the whole product, as in tablets for example. Such interfaces have many forms.

This is the Roland Lightpad Block, which is a touch-based interface that's able to detect multiple touch gestures on its flexible but firm surface.

Graphical and text-based
The graphical user interface is found in software, apps, on screens, and in virtual reality applications. It consists of visual representations of parameters and objects. Though the interaction with a graphical interface is done by using input devices like a mouse, computer keyboard, multitouch, or graphic controllers, it is termed graphical because it only exists as a visual representation.

Text, graphics, colors, and menu systems are an essential part of the graphical interface – as shown here in the digital audio workstation (DAW) Logic Pro X from Apple. Visual representations sometimes resemble real-life objects, but they may also be very abstract in their graphical presentation.

Gestural and sensor-based
Gestural interfaces process elements of a physical performance in order to translate the motion into musical or control data. For this, an array of sensor types exist, either as wearables in the performer's hand or body or via external tracking such as cameras, infrared sensors, or components that register electrical current of the human body.

One of the best-known gestural interfaces is the theremin, which creates sound according to proximity with two antennas, one resulting in changes of pitch, the other of volume. Moog's Theremini is a modern interpretation.
Today, almost everyone has access to electronic instruments, whether they be artists, DJs and composers, or students, hobbyists and casual dabbles. The term 'user' might seem cold and impersonal, but the interest is anything but. If the user is not placed at the center of development, well, let's just say that there are plenty of failures scattered through the history of electronic instruments. Of course, it's still possible to have a success without considering the humans who will play the instrument — but why begin with obstacles to overcome?

In this chapter we take a close look at the user and the interaction process. We'll consider the user experience from practical real-world perspectives, noting factors that are important during interface development or iteration.

"Interaction is a conversation. Design is something static, it becomes part of the world. It is a communication. Some of the things we understand, some we don't understand. Perhaps you feel at one with it. Why do you feel that way?"

Bob Moog "Moog: a documentary"
"Interaction is a very hot topic these days. Design is seen as not just something static, but something that becomes part of the observer. There is a communication going back and forth. Some of the communication we understand, some of it, frankly, we don't understand. For instance, why do you feel at one with your instrument? Why do you feel that your instrument is an extension of your hands?"

Bob Moog "Moog, a documentary film by Mary Halvorson" - 2001
USER-CENTRIC DESIGN

From the earliest times, electronic music has blurred the lines between composer and technician, artist and creator. Often, an artist will become an instrument maker in order to see a new idea realized. Or an engineer will seek to actively collaborate with the producers, sound designers, DJs and musicians who will rely on the finished products. While it’s true that many technological advances have been brought about by curious engineers or visionary creators working alone, a symbiotic relationship feeds both sides and cross-pollination drives innovation and, ultimately, superior results.

Of course this is nothing new; Bob Moog asked for — and responded to — his customers’ feedback in the 1960s. These days, music technology companies use crowdsourcing, crowdfunding, and early user engagement to ensure their products are perfectly on target. As such, there are multiple ways to keep the user firmly in the picture. This chapter offers a basic user-centric framework for interface design in electronic music.

USER
What are the user’s skill level, experience and preferences?

PURPOSE
Is the instrument or controller aimed at a specific situation or intended to fulfill a particular need?

CONTEXT
Is the interface intended for a live or production environment? Are there cultural aspects, historical traditions or social environments to be considered?

"Artist feedback drove all my development work... The point is that I don’t design stuff for myself, I’m a toolmaker. I design things that other people want to use."

Bob Moog — Interviewed in Design by Frank Hudson
You might be asking: why make an analog drum machine? Well, it's actually one of the most requested things from our customers throughout the years.”

Rebecca Grabb
Sympathetic Sound from Amadeus, presented by the DrumSet, pictured here.
There are as many different contexts as there are artists and genres. Nevertheless, the designer of an instrument or controller must try to anticipate probable circumstances of use and fine-tune accordingly. Sometimes this is referred to as a 'must vs. nice' exercise. Otherwise, the interface will either be generic and indifferent, or will lack elements deemed essential. We can identify four high-level contexts for an interface: several (or all) may be relevant to a single instrument.

Solo
Working alone, the artist is forced to become familiar with a range of different hardware and software. Typically, this involves learning many - sometimes conflicting - interfaces and modes of operation. In a performance situation, where there are extra demands on concentration and heightened levels of stress, instruments with consistent or commonly known functionalities and workflow are vital to success.

Collaborative
When working with one or more collaborators - say, in a band - any one artist can focus on fewer devices and give them more attention, but that attention must also be shared with the rest of the band for greater intersection. Instruments designed with collaboration in mind often delineate and separate various music-making tasks in a clear way. (See also p. 304).

Studio
A studio setting typically offers more space and time than a live situation does. This allows for larger, more expensive, and/or more delicate machinery than one would take on the road, and more time to work with interfaces that are not optimal for live use (such as the mouse and computer keyboard).

Live
A large modular synth is more suited to life in a studio than out on the road, but that's not to say that modular and other such gear aren't usable in a live context. Anything is possible with practice. However, larger and more complex instruments are simply more comfortable to explore in the context of a relaxed studio setting.

In a live performance, a well thought-out user interface is essential and the instrument must remain usable in a variety of lighting conditions. As an example, the screen of an iPad or keyboard workstation can be practically invisible in bright sunlight, whereas on a dark stage, buttons with no backlight or knobs without indicator lines can be frustrating to work with. It's also important that the device is rugged enough for the cold and wet.

As far as the customer is concerned, the interface should be intuitive and user-friendly. A well-designed interface can increase the enjoyment and efficiency of using the instrument.
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The interaction with the controller or instrument should be simple and direct - button combinations that require multiple presses or both hands are often less desirable in these situations. Shortcuts, custom programming, fast recall of presets and the like, are common techniques for an optimized workflow in the heat of live performance.

Ableton Live was the first Digital Audio Workstation (DAW) to bridge the gap between studio work and live performance. Being able to change between Session and Arrangement view provides a convenient and fast transformation from edited tracks to loops for live jamming and performance of the tracks. (See p. 506).
Power users don’t decide very much based on aesthetics. Look and feel creates appeal, not loyalty.

Joel Marsh, Author of “The Composite Persuasion”

A user will prefer one instrument over another for reasons other than functionality or sound quality alone; these can be highly personal anyway. Preference is based on a combination of aesthetic, cultural, financial and emotional reasons. The same product can be vital to one user and unnecessary, even counterproductive, to another.

A user-centric design approach calls for attention to the user’s preferences. These may include the following:

Cost
Reducing costs often results in wider availability. This can lead to devices with fewer buttons (and therefore more button combinations), no screens, cheaper materials, or even DIY assembly. However, a low-cost interface need not compromise usability.

(Build) Quality
To the user, knobs and faders with a bit of resistance can feel good, and thereby imply quality, as can a keyboard with weighted keys. In software interfaces, attention to graphic detail, legibility, and usability can convey a sense of quality.

Aesthetics
The visual appearance can be bold or balanced, vintage-looking or modern. This may affect some users while repelling others—regardless of sound or functionality.

Functionality
If the instrument lacks features desirable to the user’s purpose, high aesthetics and low price are of little relevance.

The Teenage Engineering OP-1 is small and may look like a toy, but it is heavy, suggesting durability and good build quality. It’s not inexpensive but its high-resolution screen, logical interface and usability have won many friends.

The Korg voice sample provides sample manipulation and sequencing in a small and affordable package.

The multimono from 1978 was the big brother to the more famous Micromoog. It was meant to be a less expensive alternative to the iconic Minimoog. The multimono, however, was one of the first synthesizers to feature aftertouch. Today it holds a certain vintage and nostalgic value, not to mention its fascinating aesthetic appearance.
A modular system can provide the basis for a lot of experimentation and happy accidents, but may also provide a better understanding for a learner about the relationships between the building blocks of sound and control. On the other hand, some users might prefer a much simpler interface and fewer options.

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This M-Audio CODE5 controller offers a variety of mapable control elements: wheels, pads, faders, knobs, buttons, and an XY grid. Each of these elements must be mapped deliberately, so random exploration must take place at a later stage in the sound design process.
**KNOWLEDGE & SKILL LEVEL**

Ideally, a beginner-friendly interface should make it easy to understand what everything does and how it all connects together. The novice who obtains good results from clearly-indicated actions is encouraged to explore more deeply. The more advanced user also benefits from the quick and easy results of such an interface design. In general, beginners perform best with less control, while experts perform best with more control.

**Novice**

For an interface to be enjoyable for a beginner, obtaining immediate results is desirable but not essential. If possible, the interface should aid comprehension and reduce frustration; states feedback etc. to grasp. If, when starting to learn a new interface, the connections between action and result are clear, this helps foster deeper feelings of satisfaction and involvement. Beginners benefit from structured interactions, minimal choices, constraints and access to help.

**Experienced**

Experienced users typically wish to dive deeper, customizing and optimizing their interaction with the instrument. They benefit from less structure, and from direct access to functions with minimal use of constraints. They can involve anything from editing all the preset sounds in order to create new ones from scratch, to programming an environment such as Max for Live, creating specific MIDI mappings or exploring parameters not immediately visible. Some software and hardware implement 'advanced' tabs or 'expert modes' for just such a user. Even so, advanced features shouldn't be hard to locate, access or manage.

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The Roland Space Echo effect had the manual printed inside the lid for easy access during operation. The interface is rather self-explanatory, though.

The KORG microKORG is renowned for containing the same synthesis engine and features as the larger M3000. The user can select sounds by going over the large rotary switch, while five knobs on the upper right give immediate control over the most-used parameters. Experienced players can dig deeper using the editing matrix, which grants access to all parameters.

Studies show that the level of difficulty of an interface should match - or, ideally, slightly exceed - the skill level of the user. If the difficulty is too far beyond the user's abilities, this is known as a steep learning curve. Manuals and tutorials seek to enhance user skills, but the interface should play its part by being self-explanatory as well, or at least by offering some rewards. The experience of Flow turns an interface that is usable into one that is enjoyable.

Flow is a term artists and musicians instinctively understand; it refers to a state where they are working near their skill level. In simple words, the interface is offering no simplifications to the process, and is supporting while challenging the user in a positive way.

Flow wants a fine line, rewarding the user after a certain amount of challenge. If an instrument isn't challenging at all - push a button, get a sound - boredom damages the flow. If it's too challenging for the wrong reasons - set up fifteensudo menus before anything can happen - worry and frustration kill the flow.

The Dutch modular artist, Colin Benden, has been known for his immersive live sets performed on a complex Eurorack system. For a live performance to succeed with an interface so complex, an equally high level of skill is required. It is common for skilled artists to constantly seek new and more advanced possibilities to explore and express their art.

"Good design makes a product understandable." - Dieter Rams
WLEDGE & SKILL LEVEL

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Flow walks a fine line, rewarding the user after a certain amount of challenge. If an instrument isn’t challenging at all—push a button, get a sound—boredom damages the flow. If it’s too challenging in the wrong ways—set up fifteen sub-menus before anything can happen—worry and frustration kill the flow.

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Interface difficulty

<table>
<thead>
<tr>
<th>Frustration</th>
<th>Arousal</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worry</td>
<td>Calmness</td>
<td>Control</td>
</tr>
<tr>
<td>Curiosity</td>
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The original microKORG from 2000 is renowned for containing the same synthesis engine and features as the larger MS2000. The user can select sounds by genre using the large rotary switch, while five knobs on the upper right give immediate control over the most-used parameters. Experienced players can dig deeper using the editing matrix, which grants access to all parameters.

The Roland Space Echo had the manual printed inside the lid for easy access during operation. The interface is rather self-explanatory, though.

The Tropé iPhone app, created by Brian Ero and Peter Shihers, generates ambient music in response to colored shapes drawn on the screen. No prior musical knowledge is required, thanks to a clear and intuitive interface.
INTERACTION

What goes on between artist and instrument, producer and sampler, or UI and data is both complex and simple. It all starts with the brain and the body, with the way we perceive the world and how we interact with it. The feedback loop is the essence of every interaction.

We input information to a system through the user interface using our senses, body, and mind. Even facial expressions, eye movements, or brainwaves contain information that can be processed by computers and translated into data used in the system.

The system then processes the input and returns feedback to the user through the interface—whether it is as simple as a knob position, joystick movement, a lit button or text information on a screen. This feedback loop is the essence of every interaction.

FEEDBACK

As we receive feedback from our actions, it should be very clear, consistent, and tactile. If possible, we should receive feedback on what the system is doing.

Feedback can be communicated in many ways, often by controls being in one of several different states. Here are some examples of feedback:

- Buttons pressed up or down
- Lit or unlit button/led
- Selected item marked with a color
- Blinking cursor waiting for input

The Launchpad Pro controller from Novation makes use of colors on the grid buttons to identify clips, matching the colors to those of the software. These lights, together with the labels and colors of adjacent buttons, offer very clear feedback.

On hardware, like the Minimoog Model D, the position of knobs, faders, and switches provides immediate feedback.
RACTION

We input information to a system through the user interface using our hands, body, feet or voice. Even facial expressions, eye movements or brainwaves contain information that can be processed by computers and translated into data used in the system.

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SYSTEM

The underlying system, whether analog, digital, software or hardware, interprets the state of the interface and translates it into actions, computations, voltage or the like. Likewise, the result should be communicated back to the user via the state of the interface, e.g., reporting what has happened. Whether tangible, audible or visible, the interface must communicate the state of the system.

Feedback loop

Feedback is a result of the human-machine interaction. The human could get to accept the input from a computer, an electrical sensor or from a camera. If the feedback is immediate (less than 0.1 second), the user has a feeling of directly creating the reaction. If the feedback loop lasts for more than one second, the user will notice that it is actually a system creating the feedback. Immediate feedback is desirable for a functional, reliable or even usable or pleasurable experience.

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People ignore design that ignores people.
Frank Chimero  Author and Designer

The Tempo Eurorack module from Make Noise has six colored buttons which provide feedback to the user. Each button blinks at the tempo corresponding to that specific channel (1-6) and the color indicates which note the channel is in e.g. red.

The Native Instruments Maschine software makes use of strong color contrasts to provide feedback for selections and values.
The behavior of humans towards a product, how they interact psychologically and physically, is known as the human factor. We only have a certain capacity for processing information, retaining memories, making decisions, and performing tasks, all at the same time.

The user experience is a result of the number of demands in these three distinct areas of interaction. The mental or cognitive demands, which are about how much thinking, deciding, calculating, or memorizing the user has to do. The visual demands, which are about how much visual sensory information the user is exposed to. The physical demands, which are about the amount, intensity, and detail of the physical activity required. The less the demand on the user’s capacity in these three areas, the more user-friendly or enjoyable the experience.

The human factor load is dependent on the experience and skill level of the user. As an example, playing the piano with both hands is a heavy physical and cognitive load for some people but not for others. A lot of controls on a synthesizer can put a huge demand on the visual system, forcing the user to put demands on the cognitive system trying to remember their location until muscle memory is established.

Limitations are not necessarily a bad thing in terms of interface, because if you spend less time thinking, you spend more time doing actual music.

Ilah Gabaia, Skinnerbox

Visual
When an interface offers many visual indicators or physical controls, it increases the demand on the user’s visual system. This is a dilemma. On the one hand, an abundance of visible controls make it easier to know the status of the whole system. On the other hand, too many visual elements to process make finding your way around complicated and time-consuming - especially if they are not well organized. In the studio this is less of a problem but on stage it can be crucial. Visuals, however, can ease the load on other areas. For example, it is not necessary to remember what the controls are for if icons or text labels are visible.

Mental/Cognitive
If users have to struggle to understand what is going on, remember what some controls do, or where they can find a menu item, this puts a load on the brain. The mental load can exist in many forms but is usually high when device usability is low (due to ergonomic or other concerns).

Examples of high mental/cognitive load are: menu surfing, seeking feedback or visible cues, or remembering button combinations in order to perform a task. In live performance situations, it’s important that the mental load on the user is as low as possible. Practice (and the attendant training in muscle memory) lowers the mental/cognitive load.

Physical
Physical demands on the user generally involve the hands and/or feet. As stated above, some people find playing piano with two hands a heavy physical and mental load (albeit one that lessens with practice). Physical demands can include stretching hands to reach button combinations or having to use both hands to navigate menus. Controls that are too small or fiddly, screens that are hard to reach, small buttons or controls that are hard to hit with a mouse click, or interfaces that require scrolling to navigate – all can create unnecessary physical demands.

Minimizing and optimizing load
In this example from Ableton Live’s iPad app, the user enters the modal view for easier editing after tapping on a knob. The background is dimmed, which minimizes the visual load and supports focus, and the text instructions minimize the mental load; we don’t have to wonder what is possible, but can read a helpful text. In this modal view, the user can slide the fader anywhere on the screen to adjust the value, which makes the physical interaction much easier and not as sensitive to mistakes as in the normal view. In this way, the physical load has been lowered as well.

Load balancing and distribution
On the Ableton Push 2 controller, the load is among the three types: Mental load is low here, and the screen gives clear visual information; load is minimized by placing the controls and by keeping all buttons the same black color around. Finally, size and placement of the raised buttons, and the lowered corrugated rubber surface make physical navigation easy and very act.
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time thinking, you spend more time
doing actual music.

Minimizing and optimizing load

In this example from the Arturia Mini iPad app, the user enters
into a mental state where they can focus and get into a zone.
The background is dimmed, which minimizes the visual load and
supports focus. The interface also has a hierarchical design
that helps the user to navigate through the app easily.

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among the three types: Mental load is low because text, col-
ors, and the screen give clear visual information. The visual
load is minimized by placing the control elements in a grid
and by keeping all buttons the same black color on the back
ground. Finally, the size and placement of pads, the feel of
the raised buttons, and the lowered contour of the touch strip
make physical navigation easy and very tactile.
TASK

If we start by focusing on the specific tasks a user is expecting to carry out with an instrument, there are 4 quantitative goals to be fulfilled for a successful operation. At a minimum, it should work (functional). It’s better if it works all the time (reliable). Better still, it should engender confidence and a sense of connection in the user (usable), and thus becomes a working part of the user’s world. When tasks can be performed in a functional, reliable and usable manner, this creates the basis for a positive qualitative experience.

When evaluating how well an interface performs, it might be beneficial to align each goal with the 7 Stages Of Action laid out in Donnah A. Norman’s book ‘The Design Of Everyday Things’.

The 7 stages of action for the user are:
1. Forming a goal
2. Forming the intention
3. Spontaneous action
4. Executing the action
5. Perceiving the state of the world
6. Interpreting the state of the world
7. Evaluating the outcome

An interface has to be designed to support and foresee these 7 stages with the result being functional, reliable and usable. Examples: What is the user’s intention in each situation? How does the user know which actions are possible? How does color help identify status? What controls are natural for the execution of each action?

OBJECTIVE/QUANTITATIVE INTERFACE GOALS

- **Functional**: When the unit is switched on, the software app is opened, we expect everything to work. If the app doesn’t work, the experience cannot be worse. If it fails in opening a piece of software, we expect everything in there to be functional: buttons do what they are expected to, sounds come out, etc.

Upgrading of operating systems and platforms can require the user to update the software frequently to stay operational/functional. Hardware synthesizers, mixers, DAW controllers, etc., often contain hardware parts that are designed to be replaced when worn out (e.g. a heavily used crosstalk on a DAW mixer) or can sometimes be upgraded via firmware updates.

- **Reliable**: Reliability is not only expected from software systems but also reflects durability and build quality in hardware. One of the worst-case scenarios during a live performance is that gear is not reliable and breaks down, freezes, etc. On the other hand, a lot of vintage analog gear could be termed unreliable when oscillators go out of tune or biasary circuits result in unintended ‘grit’ — often mistakenly attributed to a ‘warm analog sound’. But in general, there is no other feature artists and producers value more than reliability. Some manufacturers, though, are better than others in providing upgrades and thus ensuring greater reliability, either when issues arise or software environments change.

- **Usable**: It is simply no good if a feature or control exists but doesn’t work. For the user to have patience with the product, it must be easy to use on a consistent basis. Usability is obtainable via a fast and clear feedback loop, and an interface designed and evaluated according to these nine principles. These are also explained on the coming pages:
  - Ergonomics
  - Tolerance
  - Consistency
  - Clarity
  - Discoverability
  - Structure
  - Simplicity
  - Affordance
  - Control

EXPERIENCE

Experience derives from the execution of tasks followed by the evaluation of results. The experience we have using an instrument or controller is based on our perception, interpretation, and evaluation of the tasks performed.

The first step in a qualitative experience is that of enjoyment. We enjoy processes that work as expected and are easy to figure out. Furthermore, we begin to form attachments to instruments that produce pleasant surprises and spark creativity and self-expression.

If all price points are fulfilled to a certain degree, the ultimate experience of an instrument and loyalty is obtained — this is when artists form deep relationships with their instruments, and maybe even attribute human traits like soul, character, or mood to them.

SUBJECTIVE / QUALITATIVE INTERFACE GOALS

- **Inspirational**: When the objective goals have been met to a certain degree, users are more likely to experience enjoyment. The pleasure we receive from using instruments, the ability to interact with the interface, and the instruments in the community builds up around it. Experiences of these four areas:
  - **Physics**: The user is being sensed, seeing, and feeling the instrument.
  - **Idealogy**: The user’s values, preferences, and beliefs are related to the brand and instrument and whether it’s cool, new, or coveted, etc.
  - **Psychology**: The user being in a flow state, discovering new patterns, learning, being satisfied with the cost-benefit balance, etc.
  - **Social**: The common interests and activities of the user, their social status, sharing knowledge about the instrument, etc.

- **Meaningful & Creative**: One of the most important qualitative goals for instrument design is to make the interface meaningful — a foundation where the user can express creativity unhindered. Meaningful processes and creative results are the basis for further exploration and emotional engagement.

A musical instrument can be designed in a creative and unusual way to inspire interaction, or it can be designed in a conventional way to aid the user in achieving their goal. The most successful designs are those combining these two approaches by building on, expanding, or even challenging conventional interfaces.

- **Trust & Loyalty**: If the previous objectives have been reached, the instrument maker is that instrument as a loyal companion. As an instrument or a composing relationship, it is not just an interface, it is joy and play, and engage in creative process goals.

This happens over time to form an attachment of an instrument that carries more than just shape, and are more like a familiar soul by the user.

FOCUS:

- Interaction + Feedback + Human Factor Loads + Workflow + Knowledge & Skills

- Context + Workflow + Preference + Knowledge & Skills
EXPERIENCE

Designing a product is designing a relationship.
Steve Rogers, UX Designer, Google

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If all prior states are fulfilled to a certain degree, the ultimate experience of trust and loyalty is attained - this is when artists form deep relationships with their instruments, and maybe even attribute human traits like soul, character, or mood to them.

The user experience evolves over time and is closely related to the topics previously discussed, such as solo vs. collaborative use, live vs. studio work, and the balance of skill and difficulty that determines flow.

OBJECTIVE/QUANTITATIVE INTERFACE GOALS

- Reliability: Reliability is not only expected from software systems but also refers to durability and build quality in hardware. One of the worst-case scenarios during a live performance is that gear is not reliable and breaks down, freezes, etc. On the other hand, a lot of vintage analog gear could be deemed unalterable when oscillators go out of tune or fader circuits result in unintended 'goat' - often mistakenly attributed to a 'warm analog sound'. But in general, there is no other feature that artists and producers value more than reliability. Some manufacturers, though, are better at providing upgrades and thus ensuring greater reliability, either when issues arise or software environments change.

- Usability: It is simply not enough that a feature or control exists and works. For the user to have patience with the product, it must be easy to use on a consistent basis. Usability is observable via a list and clear feedback loops and an interface designed and evaluated according to these nine principles. These are also explained on the coming pages.

  - Ergonomics
  - Tolerance
  - Consistency
  - Cleart
  - Discoverability
  - Structure
  - Simplicity
  - Affordance
  - Control

SUBJECTIVE / QUALITATIVE INTERFACE GOALS

- Injurious: When the objective goals have been met to a certain degree, users are more likely to enjoy playing an instrument. The pleasure we want the user to derive by interacting with the instrument and the community built up around it can be explored through these four areas:

  - Physical: When the user is hearing, seeing, and feeling the instrument.
  - Ideological: The user's values, preferences, and beliefs in relation to the brand and instrument and whether it's cool, new, or coveted, etc.
  - Psychological: The user being in a flow state, discovering new patterns, learning, being satisfied with the cost-benefit balance, etc.
  - Social: The common interests and activities of the user, their social status, sharing knowledge and trust the instrument, etc.

- Meaningful & Creative: One of the most important qualitative goals for interface design is to make the interface meaningful - a foundation where the user can express creativity unhindered. Meaningful processes and creative results are the basis for further exploration and for emotional engagement.

- Trust & Loyalty: If the previous objective and subjective goals have been reached, the ultimate goal for an instrument maker is that users perceive their instrument as a loyal companion. An instrument or a controller sparks a trusting relationship; if it is reliable, has a user-friendly interface, causes joy and meaning, and lets you engage in creative processes and reach personal goals.

This happens over time and can therefore contain elements of nostalgia, since new instruments carry more of an air of history about them, and are more likely to be thought of in a familiar way by the user.

FOCUS:

INTERACTION + FEEDBACK + HUMAN FACTOR LOADS
+ WORKFLOW + KNOWLEDGE & SKILLS

CONTEXT + WORKFLOW + PREFERENCE + KNOWLEDGE & SKILLS
USABLE

Usability refers to the extent that users can employ a product fit for a specific purpose and to which degree they are able to reach their designated goals efficiently and satisfy.
**Tolerance**
Reasonable interpretations of entries, clicks and button presses. Minor mistakes are ignored.

**Examples**
A drop-down menu should take into account a certain degree of inaccuracy, so it does not disappear if the user moves the mouse, say, just one pixel outside the designated area.

**Consistency**
Consistent, recognizable presentation and interaction. Matches user expectations.

**Examples**
Highlighted buttons are shown in the same color. The same action performs the same function. For example, double- or long-pressing a button in an interface always opens extra menus or advanced functionalities.

**Discoverability**
Elements are visible and obvious. Designed and intended to be easily found.

**Examples**
Designing a ‘uni-knob per-function’ interface with a 1:1 mapping of control elements to functions. Hiding the minimum of functionality under drop-down menus or shift operations.

**Structure**
Categorization and grouping of elements according to user needs and mental models.

**Examples**
Designing the interface according to the signal flow or workflow. For example, VCO>VCF>VCA or a patch browsing process where the user first selects a genre, then mood, and Lastly sound.

**Affordance**
Usage is self-evident. Controls suggest their own usage.

**Examples**
It may not be obvious that a touch strip is configured to play notes or that a knob also has a push action. A fader moves by its visual appearance that a parameter value can be changed continuously.

**Control**
The user is in control, not the system. Appropriate pace. Actions can be reverted.

**Examples**
Being able to undo drastic actions like deleting a bank of sounds. The system should keep dialogue on screen long enough for the user to react. Using non-destructive audio editing or being able to cancel operations like freezing a track.

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Design is not just what it looks like and feels like. Design is how it works.

Steve Jobs

The drum machine iOS app DM1 from Fingerlab has nine big and easily-stuck (affordable) pads for finger drumming on a simple screen (simplicity). This makes it easier for the user to tap away without too much worry (ergonomics). Taps provide access to different sections of the instrument according to use scenario (structure), and the recording button is the traditional red (consistency and affordance).

The Kustom Bass Station 2 has clear and precise descriptions of controls: on the front panel (clarity). In the Oscillator section, the sub osc (Oscillator 2) is tucked in as part of the bigger group (structure) but is still its own entity. The switches clearly show that they control ‘what’ or ‘parameters (affordance).

Searching and selecting sounds in the software Instrument OmniSphere 2 from Spectrasonics is a guided experience allowing the user to filter down or search across genres and banks (discoverability, structure, and control).
ENJOYABLE

When analyzing the elements of an enjoyable interactive experience with an electronic instrument, we can benefit from the framework outlined below:

**Idea**

Idea is related to values and beliefs. It is about what one thinks is right and wrong, good and bad. In the world of sound synthesis, discussions about analog vs. digital are not uncommon.

**Interface**

Interface-wise, it often boils down to a user’s preference for particular control elements, such as whether a fader or knob is best suited to adjustment of the filter cutoff or the intensity of an ADSR envelope.

**Sound**

The designer of an instrument can attempt to counter-stereotypes through its design, e.g. by adding wood panels to a synthesizer to give the impression of being vintage or analog.

Good interface design should take these four axes into account and seek to balance them according to the intended purpose of the product.

**Psychological**

The brain rewards itself when it recognizes patterns or learns new skills, resulting in psychological pleasure. This is a powerful motivational factor. Scientific research reveals that the brain enjoys surprises — a fact that is very applicable in an interface context.

**Physical**

Physical enjoyment comes from the stimulation of our senses, which can be:

- **Touch**: Do we like the way a knob feels when we turn it, the tactile feedback of pushing a fader, the satisfying click of pushing a button or the feel of an instrument when we slide our hand across the surface or press down the keys?

- **Sight**: Does the interface look appealing due to its choice of colors, illustrations, typography, etc.?

- **Sound**: Arguably a vital parameter: do we like the sound we get from the instrument, whether hardware or software?

**Social**

Social pleasure comes from social interaction created when people meet friends and new acquaintances.

Social enjoyment also comes from belonging to groups and strengthening or improving one’s social position. This may involve use of customized controllers or possession of rare or expensive instruments.

**Like many things in life I do not fully understand it. For me in some ways that’s a joy, because essential input and output in any way you wish. Sometimes it works and sometimes it doesn’t. To me there’s a reason unexpected. **

Scaner (Robin Riemann) about his use of modular synthesis, "Scanning Through The Waves," horizontaltech.com

Design must seduce, shape, and more importantly, evoke an emotional response.

April Greiman

In the Teenage Engineering Pocket Operator, users find joy in a small portable device with a simple interface and quirky sounds. Pushing effect buttons provides instant audio effects without much effort - a gratifying psychological experience.

The instruments have a pleasing aesthetic, reminiscent of retro gaming devices, and the expandability of their own electronics creates a unique physical and visual experience. Socially, the devices invite attention and the inclusion of a speaker means bystanders can share the music too.

The immediacy of the Korg monologue and monotron analog synthesizers provides a pleasing visual and tactile experience at a low cost.
Physical
Physical enjoyment comes from the stimulation of our senses, which can be:

**Touch:** Do we like the way a knob feels when we turn it, the resistance of pushing a fader, the satisfying ‘click’ of pushing a button or the feel of an instrument when we slide our hand across the surface or press down the key?

**Sight:** Does the interface look appealing due to its choice of colors, illustrations, typography, etc.?

**Sound:** Arguably a vital parameter—do we like the sound we get from the instrument, whether hardware or software?

Social
Social pleasure comes from social interaction created when people meet friends and new acquaintances.

Social enjoyment also comes from belonging to groups and strengthening or improving one's social position. This may involve use of customized controllers or possession of rare or expensive instruments.

Pleasure may also derive from interaction with others with similar interests, either online or at meetups such as "modular meets" or EMS Synth lovers' get-togethers.

Sharing experiences or knowledge when collaborating, teaching, or performing also creates levels of social pleasure.

The instruments have a pleasing aesthetic resemblance to retro gaming devices, and the exposure of their inner electronics creates a unique physical and visual experience. Socially, the devices create attention and the inclusion of a speaker means bystanders can share the music too.

Audio Damage's Axon drum synthesizer plug-in has an unusual way of sequencing the voices, its hexagonal structure providing pleasant surprises to the user.

The tactile and visual aesthetics of shapes and materials, like the red aluminium and glowing red rubber wheels of this Moog Little Phatty, create an important enjoyable user experience.


"Like many things in life I do not fully understand it. For me in some ways that’s a joy, because essentially you can input and output in any way you wish. Sometimes it works and sometimes it doesn’t. To me there’s a real joy in the unexpected. **Scanner** (Robbie Rimbault) about his use of modular synthesis - 'Scanning Through The Waves'; horizontalpitch.com
MEANINGFUL & CREATIVE

When we enjoy playing an instrument, the act of doing so becomes meaningful. Meaning can also be part of the results or the process of using the instrument.

When users discover new ground, expanding their artistic and creative capabilities, they enhance their qualitative experience. It can happen for a beginner at the piano or with sophisticated software for the experienced user – or vice versa. The experience of meaning and creative flow is highly individual and differs vastly from person to person. Two different artists can have very different experiences with the same instrument – it is a matter of, among other things, experience, skill level, personality, expectations, preferences, and context. Research shows (not surprisingly) that people feel most spontaneously alive when they participate in activities they have freely chosen and are keenly interested in. An interface can support this sense of meaning and spark creativity by not forcing the user into actions that may seem irrelevant to the current task or goal.

User-centric interface design asks the question: What is meaningful to the user in this context? How do we use and create possibilities for different skill levels? What are the opportunities with this interface? Are they too few, too many, or just right? Should the design be bold and creative, or should it 'stay in the background' to motivate creativity and meaning?

Although designers seek to answer these questions within the design process, users will always find new ways of using instruments that neither were thought of. This creates new meaning and opportunities for everyone.

Some users may find a large modular system, like the one pictured here, meaningful to their workflow and creative goals.

The Throgmorton (opposite page)exacts light – that particular feature might be highly meaningful and spark creative interest with some users, while others may find it uninteresting. The two-edged sword for manufacturers is catering to the mass market on one side, potentially creating an instrument to be generic and boring, while on the other side, a unique approach to an interface risks misunderstanding and commercial failure.

I have always believed we use instruments that extend your perception.

Junkie XL (Tom Holkenborg)

Though Roland marketed the TB-3 toward guitarists and keyboard players, it has also found its way into and became defining sound of genres such as Techno and Trance. Creative users lightened it removing and inserting batteries, which resulted in random pattern-generator functions in their successors, the TB-5 and the TB-65. (See also p. 19.)
ANINGFUL & CREATIVE

g an instrument to become part of one’s personal expressive technique is highly personal and differs vastly from person to person. Two different artists can have very different experiences with the same instrument - it is a matter of, among other things, experiences, skill level, personality, expectations, preferences, and context. Research shows (not surprisingly) that some instruments are more motivating than others. Instrument use is a highly personal activity and the user’s role is central to the experience. With this interface, are they too few, too many, or just right? Should the design be bold and creative, or should it “step into the background” to motivate creativity and meaning?

Although designers seek to answer these questions within the design process, users will always find new ways of using instruments that makers never thought of. This creates new meaning and opportunities for everyone.

Some users may find a large modular system, like the one pictured here, meaningful to their workflow and creative goals.

The Thingamajigs (opposite page) react to light; that particular feature might be highly meaningful and spark creative interest with some users, while others may find it uninteresting. The two-edged sword for manufacturers is catering to the mass market on one side, potentially causing an instrument to be generic and boring, while on the other side, a unique approach to an interface risks misunderstanding and commercial failure.

"I have always believed that you should use instruments that feel like an extension of your personality."

-Junkie XL

Though Roland marketed the TB-303 toward guitarists and keyboard players as a bass accompaniment machine, it found its way into (and became the defining sound of) genres such as Acid, Techno and Trance. Creative users delighted in removing and inserting the Ladders, which resulted in random patterns. Building on this, Roland implemented random pattern-generating functions in their successors, the ARIA TB-3 and the TB-63 (see also p. 198).
TRUST & LOYALTY

To many artists, there's no distinction between electronic and acoustic instruments when it comes to forming deep relationships.

Whether software or hardware, instruments are a tool for self-expression and for achieving certain results. If this can be done without major functional issues, a sense of loyalty to and from the instrument is likely to become apparent.

It is a natural tendency of human psychology to attribute human traits, emotions, and intentions to objects. This phenomenon is called anthropomorphism and usually occurs if all the prior states of the user experience have been fulfilled to a satisfactory level. Creative and meaningful results don't necessarily provide a basis for trust or loyalty, though. That's why a sense of performance and results are consistent.

Other possible factors that increase the likeliness of anthropomorphism, trust, and loyalty are:
- Nostalgia in sound, look or features
- Humor in look, text or graphics
- Customizing done by the user
- Uniqueness or rarity
- Size (small = cute)
- Organic materials
- Branding/coexisting

I know the TR-909 so well that it's really considered a good friend. I'm aware of a lot of other hardware, but the TR-909 has helped me so many times that I can always depend on it.

Jeff Milk in "R is for Roland"

The iconic Roland TR-909 drum machine from 1983 found successful use in genres like Techno and House music. The 16-step sequencer is especially useful as it can chain patterns into full songs.

I would say that the Synth A could be called my favorite because he was always present and never let me down. Note that I call him he and rot it.

Klaus Schulze
IST & LOYALTY

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- Size ('small' = 'cute')
- Organic materials
- Branding/storytelling

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Jeff Mill in 'R is for Roland'

I would say that the Synthi A could be called my favorite because he was always present and never let me down. Note that I call him he and not it.

Klaus Schulze

By giving the Chronoboogie Euroracks delay module an unusual color scheme and a unique name, Alright Devices aimed to make it a keepsake for modular synth users. The illustrations and small figures build a sense of anthropomorphism by use of branding and storytelling.

Besides a possible enjoyable aesthetic experience visually and sonically, the prospect of emotional attachment to a module like this is greater (for some) than to a more generic-looking module.

*The EMS Synthi A from Electronic Music Systems has, since its debut in 1977, been a favorite of many pioneering electronic music artists. The Synthi A was small for its time. It’s essentially a portable version of the VCS3, and was Jean-Michel Jarre’s first synthesizer, described by him as an old friend.*