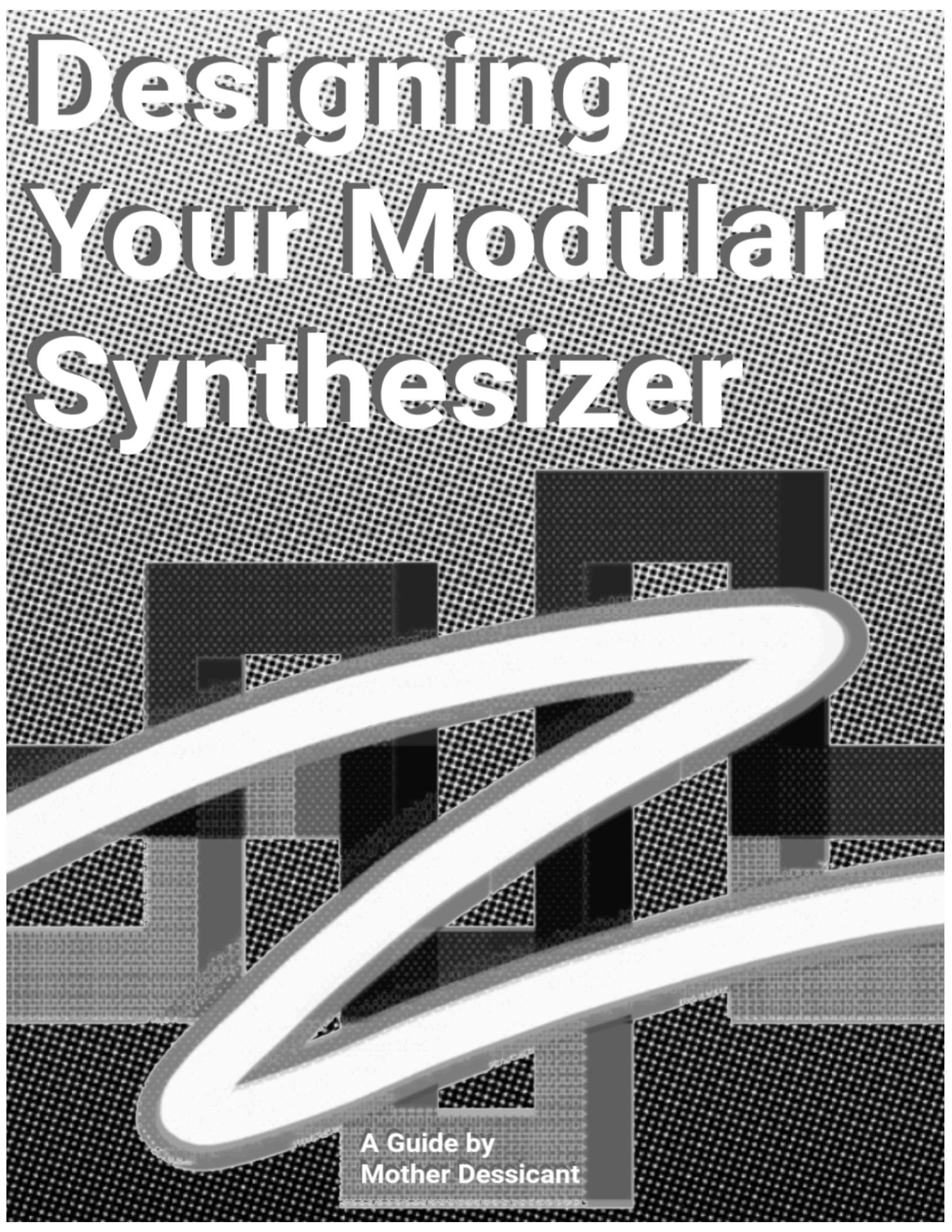# Designing Your Modular Synthesizer

A Guide by
Mother Dessicant

Designing Your Modular Synthesizer v1.1.0

An instrument design guide by **Mother Dessicant**

Introduction:

Modular is difficult. If you have any takeaway from this guide, let it be that piece of information. Furthermore, do not let this fact discourage you but inspire you like a credo. Of all the instruments from which a person may choose: You, myself, and many others have chosen an electronic instrument which requires design, construction and wiring to even begin making noise. Why?

There is satisfaction in the difficulty of modular synthesizers as an instrument. A harder road can be more rewarding. In pop-cultural terms: Would video games like Dark Souls or Tetris have reached such heights of video game success if they were just as easy to play as they seem to observers? Would movies like The Room or Rocky Horror Picture Show have reached such heights of gleeful infamy if their pure inscrutability were not something to be suffered and then recontextualized by the viewer?

In a world which seems fine-tuned to blast us with conditional ease and overwhelm us with a choice of "ok" experiences, it makes sense that we would seek solace in that which is adversarial. Somewhere deep down, humans love the challenge of media and mediums which resist the act of being experienced. To put it succinctly:

"Modular is difficult, but solving the puzzles in modular synthesis is what makes it fulfilling."

This ethos is the inspiration and purpose for this guide. It is meant to serve as a book of hints, and a collection of guiding principles when designing your modular system. Its other purpose is to pick up where other guides to the modular synthesizer world leave off. It is not within the scope of this guide to explain CV, filter resonance, FM recipes, designing an LPG from scratch, or what an oscillator does. These concepts are well-documented in existing synthesizer guides and many volumes have already been published to communicate this information.

This guide is about you and your setup. This guide tells you how to take the existing and functioning parts of a modular synthesizer and make the unique electronic instrument in your mind. It's a guide to solving some of the puzzles ahead. This is a guide to the modular world itself. It seeks to help you answer the previously unanswered:

>What modules should I get next, if any?
>Will I enjoy this new module that was announced?
>How should I arrange modules within a rack for playing music?
>Should I get a monster case or many smaller cases?
>Why does it feel so difficult to just lay down some tracks with all this gear?

And… before we can answer any of these questions, we must answer a much more important question:

>What kind of synthesist am I?

The answers to these questions are different for everyone with a modular synthesizer, but this guide has been arranged in a way so as to provide personal, relevant information to you, the reader! The type(s) of synthesist that you most resemble inform a greater profile of what details are important when designing your instrument. It's true that one person's magic module is another person's dust collector, and you'll soon find that this guide can help you determine one from the other.

Before the guide truly begins though, one last piece of business:
This guide in all electronic forms should remain free and open-source.
If this manual helps you in some way and you'd like to reach out or leave me a tip, you can help me afford more coffee, synth events, and more at Paypal: vtuerff@gmail.com

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A - "Why Do Transgender People Love Synthesizers?"

I was outright asked this question once over the wild internet. It's a good question, honestly. Being a transgender individual myself, it feels like the sort of thing I should be able to answer. At any point in the history of musical synthesis all the way up to the present day, the scene is being moved forward by transgender luminaries. How many hobbies can you say that about? The collective gut feeling is that there's something inherently trans about synthesizers, particularly modular synthesizers.

So, I thought about it way too much and I think I may have an answer. I can only speak for myself, as transness isn't a monolith and my experience will differ from others', but my conclusion is something which holds true for a wide range of people. Let me talk a bit about making music first:

Why do we make music? Not reproduce music as a classical pianist or college-dude-with-an-acoustic-guitar would, but truly create something new? Adapting a song that already exists into a wildly different genre or replacing all the lyrics also counts. More specifically, what drives us to write something from scratch and make something wholly original? The prize and purpose of creating music (or any art) is the fulfillment of self-expression.

When the song sounds on the playback exactly like it did in your head, there's no better feeling in the world. When it's perfect, you know it's perfect because you set all of the expectations. Our music is all expressions of ourselves. It's a projection of that which is inside of you. Even the steadfast concert pianist I mentioned earlier is expressing something about themselves in attaining perfect execution of a notoriously difficult piece. This sort of genuine expression actually sits very close to gender on a conceptual level, doesn't it?

In realizing who we are, transgressing the gender binary line tends to lead to the dissolution of the gender binary itself. A given single-gender friend group of cisgendered people would all express themselves in wildly different ways: A "traditional wife", raised to expect to serve their husband. A celebrity gossip writer from a large city. The lowkey hippie ecology major with a garden in every room. A goth. There are so many overtones and subharmonics to what it means to be feminine or masculine with a wide, blurry line between the two. Again, in aligning "the self" we have with "self-expression," what we've found feels beyond the word "incredible."

I know a lot of transgender individuals in various stages of their transition and almost all of them have been drawn to music as a primary hobby at some point. So if gender and music feel so similar, where do modular synthesizers come into this?

NOW it's time to talk about synthesizers! I'm very excited to do this, as you can see. Alright, ahem, this is how a classical synthesizer synthesis path works from keypress to sound output which you'll find in nearly all classical synths from Moog to Korg:

oscillator>filter>amplifier>output

By the time you're considering a modular system, you probably know this already. Modular feels like the perfect way to make frankensynths which function in parts just like the above, classical method. The Roland Juno oscillator, Korg MS-20 filter, a tube VCA from a soviet-era synthesizer design. You can see how this unlocks the full potential of "classical synthesis!" What a time to be alive.

Nobody does this.

I mean seriously, save for a few fringe passion projects or incredibly focused sound designers, I cannot say I've met a single person with a modular system who assembled it to achieve a linear synthesis path. You get like 2 effect modules and a semimodular, then some extra LFOs and modulation sources, and you find a signal mangler that literally runs the sound through wet dirt. Things get crazy and experimental so fast in this hobby that even Zoe Blade's very serious-looking Doepfer wall has synthesis possibilities within it that few closed boxes could provide. If someone is using eurorack for purely classical synthesis, I'd call them a notable exception and not at all representative of the majority.

The design, simplicity, or total inscrutability of somebody's own, designed system informs the sound. That sound is music, and the music is an expression of the self. Every system I've seen quickly falls entirely off the "East Coast Synthesis (Osc>Filter>VCA)" vs "West Coast Synthesis (Weird robot noises)" divide. With Kubrickian control we can design our perfect instrument and wire it every way we feel. We can make it sing and express the self. In fact, trying to work with someone else's modular system is frequently a confusing affair if you're not familiar with all of their modules. Even closed-box devices have all those knobs to mess with the presets, or design our very own sound from scratch. Two people with the same synthesizer will have a different favorite knob. Our instruments and music are how we love to express ourselves: With some modicum of... well, um.

Control... I guess.

Nothing has control like a synthesizer does. They're infamous for the sheer number of knobs that adorn them. It gets to the point where the limitations of a system you've designed start feeling like comfortable and acceptable boundaries to your self-expression. This is all very unlike the closed box of a prefabricated guitar or the limitless digital possibilities of DAWs (Which don't get me wrong, all the other trans individuals are using if they don't have a physical synthesizer.) It's all about finally having control over what we express and how we express it.

We can finally control our self expression with these instruments. We can express ourselves in the many nuanced ways we've always wanted to. It's important, as humans, that we search for and find how we relate to ourselves. Upon finding ourselves, we want to share these feelings with others, so we design the tools to do exactly that. Software or hardware, played or sequenced, that sound from the Roland Jupiter or sounds from the planet Jupiter. It's a skill to learn, but the prize is self-expression. No matter who you are or how you identify, you know in your head what it sounds like: The sound which is wholly yours.

B - What Kind of Synthesist Are You?

A Disclaimer: To preface this whole taxonomy, I wish to state this first:

I'm steadfastly against the use of Baudrillardian symbols to create Deleuzian dendritic hierarchies. To put that claim into plain language, I have a general distaste for the practice of sorting people into very definite "bins" so as to measure their distance from the ideal example of an imagined hierarchy or paradigm. Most of us are a mixture of two or more types and all of our instruments will be different. I would ask that people who read and enjoy this book do not place one classification as being superior to another. This guide should likewise not convey a pseudo-medical meaning to your classification like the Meyers-Briggs. It does not propose that your "synthesist type" is deterministic (you're not born a "Collector"). The following classifications are for fun and inspirational purposes only.

Furthermore, though many types of modules are discussed, I will refrain from mentioning any specific modules from extant brands. Companies in this scene rise and fall very suddenly, and I would hate for someone to give up just because they cannot locate a TZ0-Bumblepuppy from Zinkzonk Labs that a guide mentioned once. None of

all that is in here because ultimately…

This guide is meant to help the reader make the right decisions for building their own, unique modular instruments.

So let's get started: Perhaps this situation sounds familiar to you and your beginnings in synthesis:

Half a decade ago as of writing, when I first embarked on the ill-documented task of finding a few complimentary modules to pair with my Moog semi-modular, I had no idea what I was doing. Full stop, I knew nothing about synthesizers. I puzzled out on my own how CV worked, and from there I discovered how to patch. I got to a point where I could intuit what a patch might sound like before it was wired up. What I then found was a complete lack of actually useful information as to what to do next besides advertisements for specific modules. I want to make techno, but what do I need to make live techno? There's so many modules to choose from, and so many more yet to be created. What's going to work for you and what's going to wind up on your marketplace posts in a few months? Is there any way to tell?

Internet videos, show promos, and synth influencers show a remarkable ability to make a specific module seem like the most important thing in the world for any modular system. If you've bought a heavily-hyped module on release, perhaps you've felt this shock of misalignment between yourself and your new module. Not every "best module ever" is going to resonate with you. This is probably not because the module is actually bad in some way but because every synthesist has different needs. The musings and articles up to this point in the guide speak to exactly this point: Your needs are your own!

To expand in an informed way, product knowledge is not enough. We must also glean some knowledge of ourselves. If the instrument we design is an extension of the self, we should take ourselves into account just as we would the power, HP, depth and other specifications of the case. After recognizing our needs, we can engage with module knowledge and make case plans which suit these goals.

So now, at last, let us identify our archetype. After speaking with many synthesists, attending many conventions, and assisting total strangers with their cases I have identified five general directions which creative minds embody in modular synthesis. This list is not complete, you may be a combination of several types, and you should not let these types constrain you. Find the nearest neighbor here to your unique intentions and follow that path.

The archetypes are:

Explorer

"No idea what I'm trying to 'achieve' here, I just think modular is fun!"

Musician

"I want to perform electronic music live on a modular instrument."

Composer

"I want exact control over a lot of analog equipment for studio/sfx work."

Fancier

"The holistic experience of ill-explored sonic realms is my goal, not recorded 'music' as we know it."

Collector

"I just want a monster system. A towering, blinking, buzzing, musical battlestation."

Select one of these which you feel best describes you and turn to that chapter for more direct instruction or inspiration in how to grow your modular rack in a harmonious way. If you feel that several apply to you, pick the most preeminent or dominant one for your current goals first. As your needs, wants, and whims change, this guide may be needed again to guide you through a new chapter of your journey… so keep it handy!

The Path of the Explorer

To explore strange new worlds,
To seek out new life and new civilizations,
To boldly go where no man has gone before.
- **The stated mission of the Starship Enterprise***,* from Star Trek (1966)

1. - Finding Your Way There

We've all been here, literally! Almost all of us start in the exploration mindset. Modular is really cool, and you're taming the synthesis beast. It holds a lot of promise and we may or may not know what we're doing. We're shopping around, trying out some different modules, just trying to feel out what "vibes". We are just exploring. Even if we're just adding a few new modulators to a semimodular synth, there's no other "point" to this beyond exploration. Beyond our first experiences, however, this journey can seemingly go on forever once the explorer starts exploring more advanced concepts.

What does thru-zero FM sound like and how is it different from normal FM? What does an over-easy compressor do to a predictable CV signal, or feedback for that matter? Can you use a noisy distortion module without input as noise modulation on filter cutoff? What does that sound like on a sallen-key filter and can I add this to a rising envelope? What does [module name here] even do? It's one thing to answer these questions while patching, but it's something else to build and expand on a whole system towards just figuring itself out.

Explorers, like any other modular discipline, can build a system for their needs. Explorers are distinct from each of the other disciplines, for they seem to resemble them all. This is because there is a lack of intention beyond engagement with an instrument. Also modular seems cool and fun.

An explorer's synthesizer must be ready to embrace chaos, whims, and most of all a well-designed synthesis exploration system ought to be inspiring. In fact I wish to speak to this point first: What is "inspiring" about an explorer's system and should it strictly need to inspire?

This exploratory state is common among people who are new to the world of modular but some tone hounds never stop exploring. What keeps them searching?

Discovery!

In order for exploration to feel rewarding, you must discover something neat while exploring.

The information for this chapter will help you build a fun synthesizer. We're just messing around, exploring synthesis, or finding things out... but even the great explorers brought maps. And a pith hat. And comfortable khakis. There's things to know about exploring effectively with the modules you have, so let's get adventurous.

2. - Packing for Exploration

So how does someone become an efficient and successful modular explorer? Your choice in modules counts! Whether you are learning, experimenting, or merely experiencing the machine you've assembled, we're going to maximize the possible pathways to a fun and impressive result. Let's go!

What module should I get first? - If you are reading this guide before purchasing even your first module… wow! Hi! I admire your dedication to thorough research and preparation! Buy whoever showed it to you a drink or something. Anyway, my recommendation is to get a "semi modular" synthesizer module with an oscillator, filter, VCA, and envelope generator built in. You can start making noise the moment you give it power. It will probably be the centerpiece of your system for some time so pick something versatile that makes the noises you like with a lot of patch points on it. If you take good care of them, Semi-modulars are generally easy to sell to new synthesists if you ever feel like going without them later down the line. By self-patching a synthesizer which beeps and boops out of the box but can be wired to blorp and scronch, you have the perfect control panel and tool set for exploration of your modular format.

You don't need to wait for another module to start patching these things.Once you know where the ins and outs are on its patch bay you can start making complex and varied timbres of all kinds. Plug a semi-modular into itself first for a while and you're already learning to think like a modular synthesist. Pick a module for whatever you wish this semi-modular had more of.

Oscillators - You already have one, don't you? Perhaps it's in a complex semi modular, or a "complex oscillator" that functions like an oscillator with presets or different modes. These are the things that make a noise and that's what this is all about, right? You may

not be using all the inputs on your oscillators yet, but as you go further into synthesis recipes and sound-sculpting theory you'll wonder why you ever bought something without a CV-activated linear/exp FM toggle. Either way, don't go nuts here. Your first module ought to be an oscillator of some sort, and a handful can provide some satisfying FM experiments, but you don't need a ton of them. The most exciting explorations in modular come from modulating sound, not making more of it.

Oscilloscopes - Get an oscilloscope oh my GOSH get an oscilloscope. Get an oscilloscope. Buy yourself an oscilloscope. Get a scope. Did you get a scope yet? You don't need to get THAT oscilloscope, or even that other one you're looking at. There's serviceable, cheaper models that you can get for your modular format or as a little box that sits on a desk. With a CV-ready PC interface, you can use virtual oscilloscopes. I keep hammering on oscilloscopes because of how often new modular users will ignore the joys of having one. Owning an oscilloscope will help you answer the question: "Why isn't this patch behaving like I expected?" You can view what your sound and modulators are doing in real time and that direct feedback is invaluable to learning your modular format and instrument. When you're lost, Oscilloscopes are your map to stay on the trail of something good you have brewing.

Additionally: Oscilloscopes look really cool when you modulate sounds at near-audio rates! Scopes add a visual element to your modular exploration beyond the audio component you already enjoy. They open up the possibility of making oscilloscope art (for scopes with an "XY" or "2D" mode), as well as the sacred act of getting blasted on your favorite substance and watching supersaws crawl across the screen like ants on a branch. Oscilloscopes are informative, fun, and useful. Get one!

CV (LFOs/EGs/Etc) - The one word to follow here is **features**. Doubling-up on a utility module is unusual for an explorer because when expanding your bank of utilities, you'll generally want to teach your system a new trick. Give it something for through-zero, mixing CV, inverting, offsetting, quantizing, syncing and redirecting your signals. Ask yourself what the added value is in adding utilities to your system, but by all means *do not skimp on your utilities.* VCOs are fun because they make noise, but think of utilities as a way to make everything you have which makes noise make different sorts of noises. There is an exponential increase in explorable sonic area which only comes from combining rich, harmonic sources with utilities that affect them over minutes, seconds, or at audio rate.

Filters - Filters follow the same rule as above: Make sure that they add some kind of new functionality to your system, but that's easier said than done here. Be cognizant of the types of filters you're buying and how they affect sound and CV that gets run

through them. Many filters are unique affairs with experimental topology, but look first for specific hints in their product description as to their lineage. Sallen-Key, Ladder, SEM, Steiner-Parker, all of these are filter topologies which have been adapted and converted by modern designers to perform new tricks and achieve new sounds inside the modules which house them. Even so, one ladder-style filter is not going to sound profoundly different from another. Consider this before shopping for a type of filter you already own. Do your explorations call for more of this type of sound, or were you just sold on this other Sallen-Key filter by a particularly sleek demo. The sound in that demo may already be something you can achieve with the right CV! More basic filter concepts apply here as well such as accounting for multi-mode filters which can switch duties to high, low, or bandpass duty as well as the DB response curves which at time are also toggleable options on a filter. Teach your exploratory synthesizer as many new tricks as you can with a new filter when you feel like adding one in. I try not to make patch recommendations in this guide, but it is something of a rite of passage in modular synthesis to lowpass a saw wave with your favorite filter, so give that a try once it's installed!

Strange/gimmick modules - Proceed with caution, explorer! There is an air of novelty to some CV modules with "gimmicks". Modules with concepts that challenge or alter the basics of synthesis by using a novel, game-changing concept. These are features such as springs mounted on the front, artful matrices of touchable pads, reading your heartbeat, reading CV from plants, sensing the light over the module itself, geometric concepts applied to sound or sequencing, and even physical spinning elements for low-frequency oscillations. This list is incomplete and there will always be exciting new modules along these lines. Modules like this seem like interesting avenues of sonic exploration, but at the end of the day these produce voltage just like anything else. One or two of these modules will communicate to you fairly quickly just how much these novel ideas apply to your desire to make sounds. The allure of a gimmick rarely lasts longer than a few weeks whereupon it can feel like an obstacle to effective exploration. I would say if you do feel drawn to a "gimmick", it may be very inspiring for you, but do not load up on strange modules for the virtue of their strangeness as this makes your system confusing and inconvenient to use. After committing to one truly unusual module, you'll find out fairly fast if you're going to use these with regularity. To summarize: If you go strange, go strange slowly and deliberately or you will risk alienating yourself from your instrument. If putting on the motion rings, spinning the wheel, and designing a drone on a field of contact pads is gleefully overtaking your explorative sessions, you may be leaning towards being a *Fancier*: Someone enamored with the very concept of analog circuitry and your relationship to it. Give that section a peek if you find yourself preferring this type of module over the usual CV generators.

DIY - A wonderful option for explorers. Not only does building modules from kits help you acquire the tools of your trade at a cheaper price overall, but you will also gain some experience in soldering and the physical construction of modules in general. Guides (beyond the scope of this one) exist to help you trace shorts or problems on a PCB, and learning to troubleshoot from a botched build or two will help you fix your non-DIY modules down the line. Your favorite module, like a bush-clearing machete, will dull over time and long hours of use. You may need to "sharpen" it in a few years if you're using it every day by maintaining the knobs, jacks, and various components that fail. A Wasp-style filter, for instance, has a watch battery inside of it that fails comparatively fast to other synthesizer components. Learning to replace it is a great first repair due to the large size and socketed installation of the battery needed for this fix. Once you can trace issues, if you're feeling brave, you can enter the exceedingly cheap market of broken modules and attempt to fix them on your own! Take care, though, to not buy up DIY kits simply because it would be fun to build another kit: Remember that you will wind up with the module that results from the DIY project. Filling your desk with projects, either finished or unfinished, will add unneeded stress to your hobby by piling up "tasks which ought to be done" around the "having fun with my modules" portion of the hobby. If you very much enjoy the DIY aspect of eurorack and simply must keep building: Why not use your built modules to negotiate trades with other synthesists? Or even better, you can simply sell the module once the kit you've enjoyed assembling is complete. If you're making your own designs from scratch and making your own modular format, holy moly you have all my respect and remember that your best designs can be replicated and sold back into the community for any price you set for them. DIY is economical any way you look at it, so if you're ready for the extra legwork you can try your hand at soldering a kit together. I assure you: Learning to put an electronics kit together is easier than it looks!

Multi-functions - Explorers, particularly those who are looking to increase the size of their systems, have a unique use for multi-function modules. These are modules which are generally digital affairs and can act as many types of modules. The drawback is that they can generally perform only one of these operations at a time: If it's busy being a VCA, it can't also be a gate delay unless you change the mode. Furthermore, these modules are "Jacks of All Trades" in that they're merely alright at some or most of these functions, but they do work. People who own a single multi-function module will sometimes say: "I never seem to take it off somesuch mode, or whatever setting." This can make them seem like a waste, but for explorers this is a sign! **Let your multifunction be your compass for expansion.** If you never take it off the VCA mode for long, it's time to add VCAs. If you only use a complex LFO, get a similar and robust LFO module with more features. Keep your multifunction around: If you hit a point

where you're using a new mode every patch, keep it! If you tend to not use it after expanding your rack a bit, rehome it to another rack or to another synthesist who needs a compass!

3. - Load In and Set Sail!

The purpose of an explorer's instrument is to do just that (Explore!). The way that your case is arranged, constructed, and patched is as important as anything else about it! This is where a few principles of instrument design can help you assemble a case that's good at exploring sound synthesis.

Pack Light - Think hard before exceeding roughly 12U (or three or four rows) of modules. This could mean replacing what you have with better options, going out-of-board for complex needs like mixing, or simply getting rid of the modules which are gathering more dust than play time. 12U in most formats is enough to accomplish the majority of a format's capabilities given some careful module selection.

It is a common mistake to keep acquiring modules for exploration as money allows. In doing this you'll wind up an "Accidental *Collector*" with several cases, over a hundred modules, and no organized plan for most of them. With no goal but exploration this can lead to option paralysis, large portions of your collection falling into disuse, and spending much more money on this whole endeavor than you strictly need to.

Leave only Footprints - Consider unpatching completely when you are about to stop or start synthesizing. If you do not do this every time then do it frequently. Accepting impermanence is part of working with modular synthesizers and you generally don't want to walk down the same paths as the last time you went exploring. Going further than last time, yes you do want to do that, and you can leave those journeys-in-progress patched but never be afraid to start again from step one: It's like a new adventure and the best way to explore the breadth of possibilities within your collection of modules.

Mapping the Landscape - Make note of "power couples" to celebrate and compound upon successful patches. To be more clear: Every once in a while you'll find two pieces of kit that harmonize just perfectly. Their ins and outs inform each other and amount to something greater than their core functions. Finding these moments of device-level harmonization is one of the joys of synthesis exploration. Keep these close together in your case design as these discoveries are rewarding to find and to preserve. It also helps you conceptualize all those little rectangles into a patch when you have dedicated placements for that one FM discovery, that CV-generating blob, and that perfectly retro

FX chain.These couples can get old though, after a time, so if you find yourself wanting more excitement…

New lands, same wildlife - Rearrange your rack occasionally to decouple established module pairs in your mind. You can keep your subsystems together if you like, but you will be surprised how inspiring it is just from shuffling some things around. You'll start seeing new patch opportunities which you hadn't considered before, and shake up your old ways of thinking about your rig. Just a random re-arranging can make an Explorer's whole system feel new again.

Never To Return! (12U part 2) - There are some Explorers with larger setups, but at four rows of modules you probably have an idea of a different way that modular appeals to you. Commonly you'll have some new secondary or primary goals in mind such as making music (*Musician* or *Composer)*, refactoring into something stranger and more unique than just a synthesizer *(Fancier)*, or just willfully collecting more stuff! (*Collector)* You needn't lose your love of exploration to follow these paths, keep that fire burning within you, but allow your desires to shape the next stage of your modular journey. Remember, when refactoring to serve a new path, there's a whole community to trade modules with towards this new goal.

The Path of the Musician

I think it's time we blow this scene
Get everybody and the stuff together
Okay, three, two, one, let's jam.

Opening lyrics of Tank! by **The Seatbelts**

1. - You: Live and On-Stage

So you want to slay the stage. Perhaps you want to shred a keytar as a fog machine billows from behind the lasers. Maybe you want to bring Chicago House culture back to the masses. Maybe you're inspired by other live electronic instrumentalists such as Autechre, Simian Mobile Disco, The Chemical Brothers, Jean-Michael Jarre, and that list could go on forever. It's an impressive feat of audio engineering and interface design to even make that happen, and the larger acts have a professional sound team standing behind them. Can you really do it?

Yep. Stick with me here:

Live modular performance is popping up in more places than ever before. From art galleries to dancefloors, from the internet to house parties, from corner bars to music festivals, a new kind of jam is happening. Colin Benders, Nan Tang, Mylar Melodies and more are bringing modular synthesizers out of the studio to lay down some live electronica and you want in on it. Lower costs to entry and a wider appreciation of non-traditional music is helping modular performances reach more people than ever. With careful consideration of your modules, the right case arrangement, and a few tricks of the trade, you can leave the guitars and drums at home and bring the Instrument you really want to play: The one that you designed.

The Path of the Musician is for those who want to interact with their modular rack in-the-moment like an instrument. This is going to be a rack that can be played like a keyboard, switched-up like a good drum machine, and turn raw electricity into live music for an audience. This audience you have in mind could be strangers, friends, or just your cats for now. There's a lot of realities which must be accounted for or navigated to get there, but that's why I'm writing this guide about it.

Speaking for a moment as the author of this guide: I am above all a Musician. At

the time of writing I'm playing the Vegas Arts District on a monthly basis. I have a weekly live modular stream on the internet. I've played several modular-based sets at wind-choked dusty desert festivals and other large events. How do I maintain perfect, consistent quality in all of my shows?

I don't.

I've had modular shows that were absolute car crashes and I've had other gigs that felt like the best show I'll ever do… Until I top it again a while later. Performing with modular is in many ways a test of your synthesis abilities. The esoteric nature of this sort of personal instrument isn't enough to cover up a lack of practice, preparation, and panache when things go wrong. Going up against that test, getting into a conversation with your instrument for all to hear, it feels like playing Jazz, Punk, and House music all at once. The crowd is drunk and they expected a DJ but they got me but musicians like us want to give them everything they came for and more. I've done the rogue noise gig, the art gallery set, playing at a bar on Friday night, it's all musicianship. I'm a Musician type more than anything else and I want to see more of us.

There's something incredible about seeing someone perform on an instrument of their own design. You know immediately that you're seeing a unique and bombastic expression of the self: Nobody else has That 1 Guy's *Magic Pipe* or Bjork's *Ganeleste*. Kraftwerk are also notable figures in this game, bringing some of the first self-engineered electronic stage instruments into the limelight with the robotic pop to match it.

You don't need to be an engineer anymore to enter this sphere of instrument creation. The modular world has discrete parts of an instrument ready for something you're trying to design. Oscillators, filters, mixers, effects, sequencing, mastering, it all fits into one or two portable cases. It's time to design *your* instrument: Something that can be practiced, mastered, tweaked, repatched and played onstage with the same improvisational abandon that you would bring to any other established instrument. Enough pontificating, let's make some noise.

2. - Designing Your Instrument

When we're designing our own instrument, something meant to be patched up and then played live, we need to plan for that. There's actually a lot of attention which must be paid to modular arrangement in order to keep the instrument playable, but first the modules we pick must also be a good fit for live performance. When you're taking all

of this gear out of the house, the space, weight, and even the cost of this equipment you're bringing into the vicinity of a drunk bar crowd are all factors to consider. There's many ways to make your rack playable, portable, and versatile. It all starts with the modules you pick:

Mixers - These are, perhaps unexpectedly, one of the most important parts of a musician's modular instrument. Controlling what is making sound, the loudness of that sound, and when it makes sound are some of the most important functions of learning any instrument. For your mixer, get something you're going to love to play on. This will be a high-use, playable surface.

If you've ever built your own PC, think about the mixer as your motherboard and your keyboard all in one. It's going to decide the limits of the hardware your system can accept, the abilities of the system's ins and outs, and house various built-in features which make things run a little more smoothly all while serving as a primary source of control over the machine's output. If you're adding new ports and capabilities for additional channels, it's because the motherboard doesn't already have it. The feel of how it plays and clicks is important and you may need to try a few before you find the perfect match, or wind up crafting something of your own. Take a careful look at the mixers on the market both modular and semi modular before deciding.

Audio mixers in modular come in all shapes and sizes from a couple of volume knobs with a mix-out to 6+channel beasts with features like sends, VCAs, EQ, and saturation levels on every channel. There exist modular mixer systems as well, things that explode each function into its own panel for complete control over its design. To extend my metaphor about computers, there's no need to get something top-of-the-line with support for 256 processor cores if all you do is play retro games. Do not overshoot your mixer on a simple instrument because you can always upgrade, and it's better than having a huge mixer module hogging space with 2/3rds of it going unused. That said patch bays can provide some otherwise space-consuming utilities into your mixer. There's only so much space in your case and, with few exceptions, the "semi-modular mixer" formats save you HP and cost over filling your case with all those EQ, send and saturator modules. Don't be discouraged if the first mixer you pick leaves you wanting or feeling saddled with too many options, sell it or trade and try again with the knowledge of what the last mixer module taught you. Finding the right mixer for playing live is a process of discovery.

Semi-Modulars and other large modules - Having one of these in a live rack is a balancing act. First consider if this module is central to how you want to interact with your instrument. Whatever's taking up 50 to 80HP of the limited space inside of a live

setup ought to need to be there, but the needs which these modules fulfill are varied and robust. If this module is a fully-featured synthesizer in its own right and you interface with it over midi while the rest of the rack is functionally your effects section, that's an example of a needed semi-modular. For a techno rig where you want to be able to hammer out your own looping basslines, a semi-modular bass synth with a large sequencer and an integrated keyboard is a good decision. If it's meant to work like a drum machine, don't cram your gate sequencing into something small or obtuse - go big. There's certainly no need to go larger than you feel this component requires, but your hands take up physical space on it. You'll want easy access and a clear visual profile on this sort of functionality when you're playing live, so consider if it offers that as well. If it has a large patch bay, this is a great place to pack in a few extra utilities so they're not taking up HP elsewhere in the case.

Full voices - Yes. Do I need to keep writing for this bullet point? I do? Alright: Full voices strike a wonderful balance between space, cost, performability and output.. A "full voice" refers to the smaller cousin of a semi-modular synthesizer in that they generally contain an oscillator, a filter, envelopes, a VCA, a gate or trig input for remote activation, performable characteristics assigned to its knobs, and patch points for CV modulation or breaking the normal synthesis path within it. Sample players also count for this category, and are a great option when you're looking to save space or place a wide range of complex sounds in your mix from drum breaks to massive pads.

While I'm writing from the perspective of a live Techno and Ambient musician, chances are you're going to need some drums or percussion for whatever you're planning to do. These are self-contained voices which either emulate a classic analog device's drum sounds, or create a wholly-realized range of new perc, lead, or bass noises like a 303. These are the lifeblood of a live performance system. When you're performing, it's easier on your mental faculties in the moment of performance to have almost everything about a given voice (pre-mixer) in one place, not 4 or 5 distinct synthesis functions wired up all over the rack. Though these sorts of voices are generally found for percussion, if you find a particularly fully-featured full voice with a lot of sounds you enjoy, slap it in there and it's ready to be a head on your live music hydra… or at least it should get a dedicated spot on your mixer.

Menu Modules - Beware the menu modules, but don't count them entirely out. There are many useful modules with deep, on-screen menus in which you can configure all sorts of things about their input and output. Generally, in order to get the behavior to change on these modules, there's about 15 seconds to entire minutes of fiddling required in order to change their behavior all while staring at a tiny screen somewhere upon your case. This is not to say that these should not appear on a Musician's

playable instrument period, at time of writing mine has two, but the time you spend fiddling about on a tiny screen is time you are not spending playing the instrument. If you do have a menu-heavy module on your instrument, do all of your menu diving when you aren't onstage. Set up a quickly-accessible "short menu" of presets for live performance, such as easily locatable drum break samples by bpm or a filtered list of functions in a multifunction module. Preparing this module so that it does not need to be touched during the performance at all is even better. These can add a lot of versatility to the sound and capabilities of your instrument in a small package, but take care to consider if it's something that can be hot-swapped into a performance-ready state with one or two blind twists or button presses. Otherwise, set these up for success before your performance begins and enjoy the versatility they provide from show-to-show.

Before you resolve to do this and rush to get that module with a screen, remember too that computers can corrupt, freeze, and crash unexpectedly so you're also assuming additional risk of technical error. In short: Consider if the screen you want is on a performable module. Performability in this case is defined by its set-and-forget operation, or the ability to be macro-controlled somehow for immediacy in the context of a live performance. Nothing is less exciting than the music stagnating because you're trying to find a buried drum sample on a screen the size of a matchbook.

2HP/3HP modules - You may have heard people arguing against the use of 2HP modules in a live rack. 2HP is a very small footprint. When space is sparse on the instrument itself, these can seem like a very attractive way to sneak in some extra functionality. The synthesizing public's concerns are valid: The knobs are tiny and become lost or hard to turn behind the many wires that are plugged into them less than half an inch away. Worse, it's all too easy to nestle these between other, larger, playable modules and in trying to turn the tiny attenuators on your 2HP module you'll bump the tuning knob of something adjacent. 2HP modules, unless you have tiny hands, are unwieldy at best and at worst functionally inaccessible in a densely-wired system.

The exception to this rule of "no teeny-tiny modules" is twofold: One is if the 2HP module has no knobs. There's 2HP VCAs, LPGs, S&Hs, and more which feature no knobs, only patch points. Since these aren't a point of live control, you can fill a blank spot in your rack with needed utility that requires no direct knob access. Just make sure that it's located in a spot where the cables are unobtrusive to other functions. The second solution, unbelievable as it sounds, is to get the same utility in 3HP. The author of this guide does not count themselves in the small hands club, and 3HP gives just barely enough space to render a standard mini-potentiometer "turnable in the moment". You probably won't be jamming on this knob, but for submixers, effect algorithms, and other things which may only need slight, deliberate tweaking during a performance

they're perfectly serviceable once given those extra few centimeters.

This will of course give you an odd number of HP on this row: Be sure to either pair it in its row with another odd-numbered HP module, or if you have sliding nuts instead of threaded strips in your mounting rails, you can opt to keep the 1HP space open on either side for easier operation of the 3HP module. You can also bias other modules on the row to keep an accessibility gap between other knobs important to your performance. 1HP is small enough to keep a TS/TRS cable tip out of the power below, so don't be too scared and let it ventilate. Never underestimate the utility of choosing nothingness on the face of your designs.

Buffered Mults / Precision Adders - Is it worth dedicating space to a buffered signal multiplier when so many 0HP multing options exist? Surely there's something better for the slot it takes up, right? If you're making beat-focused music, I feel that the answer is yes. If you don't have enough synced clock sources to tie your instrument together, and they must operate to a shared clock, buffer your clock. This is a controversial take, but there is a reason for it:

If you only need to mult a signal once, a single stackable should serve just fine. Any more than that and a buffered mult offers "clock security." Plugging into a 0HP flying mult or "octopus splitter" can result in decreased amplitude of your clock's trigger signals, making them occasionally unreliable to high-tolerance inputs as more versions of the clock signal are spread all around your rack. The other reason is that 0-2HP, one-to-many passive splitters are noisy by virtue of their passive design. So much as bumping this cluster of cables can introduce noise in the line that would cause your clock to randomly skip around. Many users enjoy and embrace this randomness, but if your clock must be correct, and it must be multed to reach more than 2 destinations, then it should be buffered in the name of keeping it reliable. If you're live-patching clock sources on a passive mult, everything gets thrown into chaos as the mult connects. Keep the beat steady by buffering it.

A final suggestion on this topic: If you're multing to keep more than two v/Oct signals perfectly in-tune, consider a "precision adder" as well for additional, individual control over the multed channels. This adds the possibility of having multi-module key changes sent through the adder, which can then reach anything that needs retuning in your rack. Simply mult your signal for changing the key and add it to your other V/Oct sources.The eponymous "added" CV in the precision adder will play these V/oct sequences on top of the baseline key you've established. Simply jump your whole song from C to E for another chorus with the turn of a single static CV knob. This is, for a musician, the underrated utility of precision adders: Fast transfers to new musical keys

and a transposed scale or arp without individual oscillator retuning.

Mutes - Mutes are a part of live performance. Sometimes the bass drum needs to go away for a while, let everything else shine as the subwoofers breathe a little, then have it come back in a massive bass drop. The sudden, snappy characteristics of a mute can be avoided if preferred by utilizing muting modules which run on vactrols. Standard vactrol behavior naturally envelopes the movement from the on to off position and saves the sudden click of losing an element in your track. In this, they're far more forgiving in a live setting. Also watch for "three position mute switches" with a latch on, latch off, and a "momentary on" which flicks back to off when you let go. Dappling these switches to let a burst of sound through can sound organic and funky (in a good way) when used in a patch that strictly follows a master clock. Try chopping a vocal sample with this manual tremolo and enjoy the new control surface that momentary latches provide.

Digital Oscillators / Analog Warming - I know what you're thinking, full analog forever. I mean what's the point of eurorack if not to bring analog flavor to the masses? Before you go on tour with those analog oscillators, consider how sensitive some of them can be. A securely-racked oscillator isn't fragile, strictly speaking, but there's serious drawbacks to letting these leave the house. Analog components are very sensitive to temperature changes. An instrument you tuned every oscillator on thirty minutes ago will fall swiftly out of tune after the bar fills up, when it's under stage lights, or when you find out the stage is on the patio. If you still want some of that analog character, it's less of a headache to tune some digital oscillators by ear and run them through an analog warming module. Sending a very subtle analog LFO to a digital oscillator's FM input is another, more audible way to work that legendary analog detune into a reliable pitch.

Note: If what you're doing isn't beholden to a scale or relative harmonies then don't worry about it. Do whatever you want, you rebel.

Power Word: "Performance" - When considering which modules to include in your instrument, the word "performance" in modular is not as meaningless as it is in the car or sports drink world. Modules with "performance" in the description of their primary function such as "performance mixer" or "performance sampler" are generally designed and tuned for a live, immediate use that expects human fingers to be upon them. These modules will generally have generous knob spacing, easily-accessible changes in behavior, and spacious control surfaces to jam on. Performance, in the description of most modules, is referring to exactly what you want to do: Perform!

Even when a module does not have the word "Performance" in its product description, remember to select modules which allow you to interface with your machine

in a very immediate and deliberate way. A stack of euclidean sequencer knobs with follow-along lights are pretty great, but having a field of step-sequencing buttons is even better. Imagine if a guitar had a knob instead of strings over the pickups. In this instrument, you would have to turn the knob to select the combination of strings you wanted to play (perhaps with a tiny screen saying which strings were selected) then smash the same, mooshy encoder downward to play those strings. It would work, yes, but it would also be frustrating and much less dynamic. Don't pigeonhole yourself into a suboptimal performance environment on your rack, pick modules that let your creativity flow.

Enter the Matrix Mixers - Do get a matrix mixer for your effects section, and allow me to explain why. The space you have to develop your instrument is finite. If you've been playing on modular systems for a while, you've encountered this thought: "Let's patch this into effects, I need a - oh darn I already used it in this patch." This is where matrix mixers come in. While the concept of a matrix mixer seems very experimental and "West-coast" at first blush, submixers excel at post-processing a sound. If you have one module each for Reverb, EQ, Saturation, and Compression, with a 4x4 matrix mixer you only require these four modules and a four source mixer to dial in how much of four audio sources are being sent to all of these FX at once! It can be a matter of tatse, of course, to have several delays, compressors, and FX units, but that's not always strictly needed. A sub-mix from your matrix mixer will generally behave as if the single effects unit had multiple in-ports with part-by-part attenuation. Pick your matrix mixer after picking your post-processing modules though, so you'll know how many, if any, of your mixer channels will need stereo capabilities.

Buying Used - Taking your modular instrument out of the house is placing it in harm's way. In practice, and with careful treatment, it's unlikely that something terrible is going to happen to your instrument but it's true that this is risky business with such sensitive electronics. Practicing your instrument will also cause wear upon the modules' parts. Perhaps your wedding ring will scrape the panel while playing it. Maybe you'll be whipping a patch cable around in excitement over your "New Module Day" excitement and accidentally leave a big silver gash on a brand new module… (True story.) If you can stand it, it's just better to have spent $230 on a module that sounds fine with scuffs already on it than $350 on something pristine. You'll be a little less nervous when trying to fix it as well, if it comes down to that!

To come at this from another angle, bringing it from place to place in a vehicle, or just carrying it in your arms will jostle the modules a bit, probably enough to cause some wear marks on the face plate near the screw holes commonly called "rack rash". This does not affect the sound or integrity of the module in any way, but if you're going to be

marring it up anyway with a life out of the studio. It's nice to get the module for cheaper with a bit of wear beforehand. Embrace the entropy, buy used. This also keeps the person-to-person module market active which is good when you're the one who's looking to sell!

EQ, Compression, Outs, and other "boring" modules - You gotta. If it is the purpose of your rack to output a dancefloor-ready banger from scratch, you'll need to notch down a resonant peak, isolate the mids on something, and stuff a bass drum transient on a sample as you build your track. Not every voice will have master-level control over its frequencies, regardless of your module selection, as so much of subtractive synthesis deals with the manipulation of loud, primitive shapes of sound taking up the full sonic spectrum. Compressing your volume jumps with a master-bus compressor means less instances of deafening your audience on accident and losing the crowd. Get some line level outs for speakers or headphones, it will make practicing at home or on the road much easier and more immediate. Some modules can provide a secondary headphone or speaker monitor set-up so you can accurately monitor your own output onstage through a cue channel. Output modules make setup at the gig so much easier because "outs" will commonly give you an end of chain master volume control for matching the house's needed volume levels. If you're making music from start to finish inside of your rack, you also need to mix and master it on the fly so be sure to dedicate some of your rack and practice time to production and leveling basics. Your sound will thank you.

Control Surfaces - Control surfaces are modules with the sole purpose of giving the human control over the machine in some way. This generally takes the form of XOX-style gate sequencers, fader banks, contact microphones, touchplates, and many more. While your mutes, mixers, and sequencers will likely be playable surfaces, these modules generally only define a physical interaction point for play and send CV to a different module that actually triggers an event or processes its effect upon your sound. It's up to you to pick these! Go nuts. This is your instrument and you're the most qualified person to decide how your instrument should be played, but remember to consider immediate, understandable, playable control surfaces over obtuse, high-concept mystery rectangles. (Unless that's what you want! If so, are you sure you're not a *Fancier*?) If there's a lot of esoteric button combos, that's not necessarily a deal breaker in my experience as plenty of people perform live upon Elektron's non-modular offerings. Just keep in mind that you need to deal with and memorize how to navigate whatever obstacles you're placing in your way to achieve purposeful control. Believe it or not, it is possible to design and make a great instrument, then never practice and be bad at playing it. Pick control surfaces you'll enjoy practicing on to, in the parlance of our times, "get good."

3. - Arrangements for Play

Musicians have a lot of special concerns when it comes to case organization. Once you've selected some great modules, here's how you can arrange them well for a rack with instrument-like playability. This section also contains some general tips for performing with modular and handling matters on and around the instrument itself.

Shaping the Face - Great artists steal, so look at the interfaces of your favorite classics for inspiration here: The 303 made plenty of room for the sequencer because programming it was central to its operation as an instrument. The great drum machines have gate sequencing on the bottom or velocity sensitive pads in a big, uninterrupted field that's ready for your fingers to drum on. Consider some of the things about the instruments you already enjoy and pay attention to the attributes you like. This device might have a huge and easily-accessible cutoff knob, a faderbank for the mixdown, or a particular filter type you enjoy. Let the work of those designers inspire you when crafting your instrument, because that's a major factor in making your instrument fun to play! Fun, as an attribute of your instrument, is just as important as sounding good.

Also many larger modules will have an area with knobs and control surfaces, and a different distinct area with its sizable patch bay. When arranging your rack, bias these modules so that you won't have patch cables passing over the knobs. If there's a playable, performable module such as a full voice, semi-modular, or control surface on your module, you will want to plan these modules around the patch bay locations of the larger ones for easy access after it's wired up. It's not about keeping your patch cables short and perfectly sized so much as keeping cables out of the playable areas. That big XOX sequencer isn't very immediate if there's half a dozen cables you need to shoo out of the way before using it. In fact, where to place a patch bay on a high-use control surface is quite a topic…

Up Up Down Down Left Right Left Right - It's inevitable, some of your modules will have primary patch bays on the top, and some will have it on the bottom. Maybe these wires obscure line of sight to important status lights or are too close to gain knobs. When choosing positions for these modules, consider this: Horizontal vs Vertical orientation. As an example: You have a vertically-oriented case and your performance sequencer has all the outs on the top, your line of sight and touch to the buttons is obscured by cables when you look down at it. L-shaped cables can help with this somewhat if the Ls don't lie over the controllable surfaces, but you can place this module horizontally and everything about it changes.

Horizontally oriented, the cables face the rest of the sequencer. All of the knobs are right there, laid out and accessible. An external control case that sits away from your main case can accomplish this, and so can L-shaped cases. The lesson here is "Place your top patch bays on the bottom, and the bottom patch bays higher-up." Keep those L-shaped cables though for patching along the vertical/horizontal divide, as L-shaped cases can occasionally create physical conflicts between the position of a horizontal and vertical I-shaped cables once they're plugged in. Orienting your case diagonally, facing just below your shoulder height from the center of the rack, can partially and sometimes entirely achieve the high visibility and accessibility you're looking for.

I've found left and right to be less of a pain to account for. Keep large forests of cables away from important visual parts of your system such as the sequencer's step lights, commonly changing knob positions, or screens (Yet another reason to reconsider having a lot of screens on a live instrument). That's about it. In fact you don't even need to put your right-oriented patchbays on the left side of your case. So long as you can see your system, the goal when placing side-oriented patchbays and completely-knobless modules is to help facilitate your "Patch Man" path. What am I talking about, you ask?...

The "Patch-Man" Arrangement - Sometimes making a patch bay that actually works for you is harder than putting all the patch bays all in the center. Once you have three or more rows in your case, it's basically impossible to just put the high patch bays on the bottom and the low patch bays on top because your middle row will be inaccessible. What do you do? Make a "Patch-Man" level!

To explain this a bit further, arrange your patch bays so that you can draw a maze-like, wandering line from any of your patch points to another without crossing a knob or control surface. The line doesn't need to be straight as when you're working with right-angled cables they'll generally run flat like a length of string. If it helps, imagine a little "Patch-Man", like the classic video game, that needs a path from one jack to any of the other jacks to eat all the dots in them and finish the level. You don't need to be perfect about this sort of arrangement, but this "contiguous patchbay" layout ensures that you'll be able to run cables through the forest of jacks in the patch bays instead of across the important control interfaces on all of your modules. Depending on your cable color choice, the braids that result from these dense, contiguous patchbays can become a part of your synthesizer's live, visual appeal. And you DO want to show it off…

Show Your Gimmicks - Credit where it's due, I believe that this tip is from Molten

Modular. In a video that broke down what they learned from playing a gig for the very first time, one of their tips was this: "What you are doing is interesting and the audience wants to see it. Have a way to show it to them." Going back to the guitar as a basis of comparison, how less exciting would it be to watch someone absolutely shredding it at a live venue but you can't even see them playing the strings?. It would just be someone fiddling around behind a mystery box. In this way the guitar, and other stringed instruments like it, are instruments designed with the audience in mind.

At time of writing, there's a novelty in eurorack which a non-synthesist audience wants to see. This is in part so that they can gain some understanding of what they're watching. For those of us more well-versed in the audio gear scene, who among us hasn't marveled at our favorite band's pedalboards and amp stacks onstage before the band even comes out? You're playing a personally-crafted instrument with fascinating controls, even if they're gimmicky, so make sure the audience can see them because the instrument itself is interesting. If you're playing the bass on a fidget spinner, conducting with a Nintendo Nunchuk controller, and tapping a piezo attached to the case itself to play a solo, make sure that the audience can see that.

Two easy ways to accomplish this without ostentatious control methods are by playing back-to-audience with your synth standing up, or playing at the audience's level with your modular flat on a table. If you're doing a noise performance, it's common convention in this genre to put your setup on the floor for dramatic effect. As modular performance becomes more widespread, I look forward to new and interesting ways that performers get around this hurdle such as with carefully placed mirrors, or cameras placed around the case for live video feeds to audience-facing displays.

The Panic Preset - This bit of advice is something Mylar Melodies has spoken about in one of their numerous videos detailing their thought process in designing their own live music system. Sequencing modules, particularly ones which control large amounts of your case, will tend to have save slots for recallable presets. It's good to have at least one preset handy which can be immediately recalled just in case your jam goes a little too far off-track. After having played many live sets myself, I can affirm that the "Panic Preset", which I needed in order to pull something strictly listenable up quickly, has grounded many a patch that had taken flight into unlistenable frequencies and undesired microtonal messiness. Hit "Recall" to return to familiar territory and continue jamming, easy peasy.

Conditioning Hairy Power - If you're taking synthesizers outside the studio, it's worth it to get a power conditioner. Generally, power conditioners are considered to be studio equipment which can lower the ambient noise of your devices and help protect against

power irregularities. The smaller, more portable versions of these power conditioners are visually similar to a normal multi-outlet surge protector. Surge protection is important but this is not the only service they perform: More than once I have brought a mint condition semi-modular out to a synthesizer event for quick jamming or an instructional seminar only to find that the device won't start once I brought it to the auditorium. The power from a given venue may act strangely upon your modular equipment, and it's a good idea to find a small, portable power conditioning unit to make sure that everything will work once you arrive. If you're only surge-protected when you're wired into the city's power, directly out of the street at a fair, it's a matter of luck as to whether it will turn on without some conditioning. This problem is rare, but having your own power conditioner with surge protection should make it happen zero times regardless of how clean the power is at the venue.

The Cases for Stasis - While patching and determining the precise paths between modules in your instrument, it's very likely that you'll find something so useful, so pleasant-sounding, or just so needed that it never truly needs to come unplugged. This is how cases can slowly reach a point of being "perma-patched". Contrary to good practice for "explorers" which dismantle the audio paths every time, I would advise musicians to find these strong bonds between modules where they form and try leaving them plugged in. If you never feel like changing these wires, you have a permapatch brewing. There are low-profile L-shaped cables as well as little braces and rubber strips which affix under metric screws to assist you with arranging your cables once they functionally never need to be moved. A home system may not have the lid slapped on it very often, but a live or wandering system may need to be covered while patched before the big show for protection during transit. Good cable management for your permapatches helps keep cables from getting crushed by the lid, pulling on their jacks when tweaked by errant movements, and from obscuring the all important knobs, sliders, and control surfaces you'll need access to for performing. If it's permapatched, you owe it to yourself to manage the noodly chaos.

Good cabling practices aside, permapatching creates an instrument which can be practiced because it is predictable and standardized. The Ramones notoriously only knew a few chords before becoming punk rock superstars. They would not have been able to reach such heights with basic skills if the order of their strings changed from gig-to-gig, or the length and number of necks on their guitars was in flux. By buying for, adding upon, and tweaking your instrument all the time, you are doing exactly this to yourself. It's a common gripe from synthesists that despite being able to make music, and constantly improving their rack, they can't seem to get anything worth recording. A lack of stasis is why. You can't even play something simple with proficiency if you're constantly changing the instrument. Practice is important with an instrument, even one

you've designed! Build that muscle memory, and don't add or move things around unless you feel it would make the instrument more playable or enjoyable. When you do make a change, causing change should be worth the disorientation it causes. You will likely go through a cycle of:

Revisions > Practicing > Proficiency

I call it a cycle because revisions are not categorically bad, in fact making revisions based on pain points found while practicing or performing is how an instrument grows into a better version of itself. That said, after implementing your redesign, there will follow a practice period where you relearn how to play a mostly familiar instrument with your new additions. Take care to not accidentally paralyze yourself by never leaving the revision stage!

"Bee Cables" / Designating A Delta Color - When the time comes for a performance, your patching brain need not be entirely turned off. Depending on the type of show, I've patched up just the bare essentials of a patch before and live-patched the rest of my connections mid performance. When live-patching around a permapatch that supports important functions like "Channel 1 is Bass" or "The sound comes out here", I enjoy designating a "Delta Color." This is a cable color or style which represents the difference between default patch decisions and temporary ones, and it doesn't appear in your permapatch. When you're grabbing that extra LFO or unpatching something familiar to steal a taken modulation source, it helps a lot to visually distinguish these connections from your "default" patch.

I prefer high-visibility colors for this, and have an easily-identifiable set of braided cables with a black and yellow bee pattern which became my Delta Colors for virtue of their versatile length and bright colors. They're not beautiful, but they're very easy to spot among all the flat cable colors which are already plugged in all over the instrument. After a long period of time you may memorize the patch on an instrument by heart, but so have I and I've still found this trick to be helpful for unpatching my flights of fancy whilst onstage and at home. I pull the bee cables, simple and done, then move along as practiced.

Thinking outside the box - You've puzzled it over, and you just can't fit the keyboard module in your beloved instrument anymore. Maybe you don't want to fidget with the walls of wires, you want an external device to handle your complex gate sequencing needs. No worries, as this is common. If you're bringing an external control surface, audio interface, or even a sound system to a gig, keep all of the equipment, cables, and more in a little list wherever you feel comfortable taking such notes and take it with you.

On your phone, or on a little piece of paper, this will help you check your loadout before properly leaving to face the crowd. It also gives you some peace of mind when packing up afterwards, as you can go through the list before closing the trunk and heading home. If your loadout doesn't change at all from performance to performance, this list can be reused so it's worth making one to prevent forgetting "That one thing, oh no, what now!?"

Do An Amp Stand! - Amp stands are sturdy little things which are meant to hold several dozen lbs of equipment steady and upright. They're obviously made for amps, but I've found that when playing on taller and heavier racks, let's say anything above 6U, having the case upright makes playing it easier than laying 9U or even 12U flat on a table and hovering over it. You don't need to break the bank on a vertical case: Get an amp stand. If your case is box-shaped and doesn't have a strange center of gravity, a ground-level tilted amp stand fits perfectly on most medium to large tables and brings all of your controls front and center. These V-shaped devices of metal and rubber are engineered to support something heavy, boxy and tilted upright, so you may be pleasantly surprised by how securely it holds and angles your larger instruments! I'd like

to extend a thank you to fellow synthesist Crystal Crumb for this knowledge.

The Path of the Composer

"A composer is a person who goes around forcing his will on unsuspecting air molecules, often with the assistance of unsuspecting musicians."
- Frank Zappa

1. - In the Studio

So, it's time to bring modular into the studio. There's a lot of reasons why a composer might want to do such a thing. In a world which is at the time of writing dominated by DAWs from idea to final track, it's appealing to let some of your sources spill into the real world. The notion of a "composer" brings to mind studious aristocrats, perhaps in the 16th century. In the future, we may look back more commonly at Brian Eno, John Cage, Hans Zimmer, and Ryuuchi Sakamoto. Even Frank Zappa, after a long career of leveling obscenities at the mere notion of machine music, relented on this stance when he realized that MIDI could play what humans could not yet achieve.

This is an interesting anecdote by today's standards because we're heading back in the opposite direction. Independent and hobbyist producers are bringing more physical instruments and CV interfaces into their studios for natural, organic patterns and modulation. The "humanize" button feels silly when you can involve a real human. DJ-Shadow, J-Dilla, Outkast's Big Boi and far too many other producers to name have hammered out sampled grooves by hand to humanize their beats. By exposing the digital realm to human control through a modular device, we can achieve compositional methods which leave other producers wondering how you accomplished such off-the-wall noises. Buttons, such as on an SP-1200, are percussive yes, but have you considered the organic, fluid feeling of a live knob turn vs a sequenced one?

For some composers this decision is about that vaunted "analog sound": Real transistors, vactrols and MOSFETs with analog feedback through watch-battery Wasp filters syncing to the frequency of SID chips for screeching leads. They're looking for atonal noise swashes and warm, natural bass tones that stand out in a mix. In this case, the need for some sort of interface seems obvious, but it can go much deeper than that. Finding a way to merge the world of your DAW and the physical sound circuits on your desk may begin with getting sound from the instrument to the machine, but it's only a fraction of the possibilities modular provides. Learning what these possibilities are will help you unlock the most of your physical instruments and interfaces, particularly if you're not afraid to get a little experimental.

There's quite a lot to cover in this section, and a lot of use cases which may or may not fit your type of compositions or studio setup. Take what you need, and innovate what you don't, but let's get started!

2. - Selecting The Orchestra

Audio Interface/Output Modules - Musicians are, in this guide, encouraged to consider their mixer first as it will be the command center for an ongoing constant mixdown for a live, electronic, musical product. For similar reasons of importance, the other first thing a composer should consider is their interface. Someone who is looking to send, create, capture, or accompany compositions with a modular solution has three ways to go about getting their work out of one box and into the other. Each approach has unique benefits and challenges, but ultimately it will inform the number of channels and voltage levels which your audible output will need to hit the interface at.

For the newer synthesists reading this: Modular formats have an unusually high volume/VPP. It can make the "magic smoke" come out of cheap mixers and stress the parts of other mixers that aren't ready for this amplitude level of voltage. Placing the right USB or audio cable interface in your rack is a great way to make sure that whatever you're recording on is receiving the correct levels of voltages. Get an interface module that best suits your needs based on these use-case examples.

Capture and ReSample - This describes a setup where it doesn't matter how raw your output is, or if it's even in stereo because it's going to be processed through a sampler or workstation. If you have external equipment, such as a DAW or performance sampler, and you plan to create raw noises which you will use like samples from a sample pack: Congratulations! You have the least work to do in terms of getting noise to your workstation. You can compare the relative output volume of your modular format to your receiving device's tolerances (be it an interface, sampler, or just a tape deck) but "Line Level Outs" from a dedicated module for such things will probably be enough to tame the higher voltage ranges you'll find in modular. The drawback of this approach is that whatever device receives these samples will need to perform all postprocessing. It's also not going to produce full tracks, just the pieces of a track, perhaps, which you will need to go about rearranging later. This requires the least number of modules to achieve, but requires a fair bit of work after the act of sound creation. Sample-heavy producers and sound-effect designers will probably have it no other way than this!

Multitracking - These setups generally make use of modular or other high-VPP

interfaces to make 3 or more recordings at once. Multitrack recording has definite upsides for music producers, such as the ability to adjust your mix after recording it. If you're multitracking or performing post-production upon your various drum and synth channels, multitracking may be for you. As always, make sure that you're outputting at line level, or perhaps you will choose a pricer USB interface that maintains the noise-to-signal ratio of modular formats. The drawback of this approach is the absence of live performable effects and post-production steps such as compression and other techniques for "gluing" several elements together in a mix. You'll be striking a balance between the raw output of the capture and whatever you seek to do to the sound once it's in your DAW or similar musical arrangement device. You can record raw then re-perform on physical, modular effects through an out>in loop on some multitrack interfaces, but it will still be an extra step unless you're willing to bake those effects into each track's raw input. Experienced producers who are not interested in performance but are skilled with handling raw material will likely prefer this approach.

Stereo Pair to Reel - This recording setup is my personal preference, and by far the most temperamental. I'm referring to a setup in which the sounds, mixing, compression, and effects of each channel are handled within your modular hardware. A computer only comes into play as a recording device, or as a file converter to more easily share the work you're creating. The benefits of this approach are numerous: The natural cohesiveness of a sound made all at once in a single synthesis environment is a characteristic sound, evocative of early House, Acid, and Ambient music which was sent directly from the creator's studio equipment into a tape reel or stereo sound file. The multi-hand, multi-CV direct control over every element from raw input to post-processing lends great utility and a personal touch to this approach. It's also the easiest to record: Any interface which accepts your stereo mixdown is ready to record exactly what your music, mixer, mangling and mastering machine can accomplish.

The drawbacks of this approach are, perhaps most obviously, you're buying more modules to achieve it. Another drawback is that bad takes, like bad takes on a guitar, will generally need to be redone instead of fixed in post. It's possible with a DAW to make limited adjustments to odd sonic phenomena, volume spikes. or other strangeness which results from modular formats but that's not always enough. With this modular-to-stereo-mix approach, think of it like making a whole, fresh, baked loaf of bread: Maybe you can scrape a subtle burn off of it, or snap off a tab in the dough shape, but you can't take anything significant out of it. If there's too much egg in there, it won't taste right and you can't filter that out of the baked bread without destroying the whole loaf and starting again. All this is to say, composer-musicians and self-playing patch designers will likely prefer this method, just be prepared to monitor your output in a detailed way before recording. Knowing a few tricks for fixing the odd mistake in a full

mix will also serve you well, but you're going to be doing a lot of re-takes with this method so be ready for that.

VCOs - A common phrase in the world of synthesizer theory is "You can never have too many VCAs." I agree with this affectation now, but it's a common mistake for beginner-to-intermediate synthesists to feel "You can never have too many VCOs." This was also me, by the way, I did this even after I was warned about it.

Having an analog oscillator or complex VCO with a hundred sweet spots is great, but modular is terrible at polyphony. Yes, you can make true polyphony happen, you just need to give every voice a filter, a volt-per-octave signal, envelopes, a vca channel, you might want a switch for switching modulation between vca+filter channels, and don't even get me started on slew. With the exception of "drum voices" (complex VCOs which are generally sold as self-contained percussion sources) managing many voices in a composition is something modular can apologize for, but not make up for. If you're just here to compose, you can wire literally anything with polyphony from a thrift-store keyboard to a machine-controlled VST with the right utility module.

If it has to manage 4+ voice full-polyphony, but it also must be all-modular, you might be heavily leaning towards a "*Collector*" or *"Fancier" archetype since the goal is more about being modular than is about achieving polyphony*. Generally a composer will prefer the right tool for the right job: I offer that this is why so many artists with modular instruments still have a polyphonic keyboard somewhere in the studio. Modular is the most expensive and complicated way to get polyphony in your studio. There's nothing to prove here about the tools you're using, this is about the output. If you're chasing the slight, natural detune from 4 analog oscillators, get a keyboard with analog polyphony. Polyphony can be achieved, but the strength of modular synthesis is in utility…

Utility and Modulation - Utility is where analog modular equipment truly shines. Once it's in your hands it's as exciting as a new voice because complex modulation effectively multiplies what a given modular sound source can do. If you have 4 Complex VCOs, a generative sequencer, and a mixer, you have a showcase of those 4 Complex VCOs. If you instead have 2 complex voices, a multi-LFO bank and a function generator, you have an explorable sonic playground with almost limitless potential. Going through-zero at audio rates with an overdriven vactrol LPG acting as a VCA is what modular is good at. VCAs can be chained to allow for longer, multi-operator modulations upon another modulation signal's intensity. Modulating and affecting a sound source will give you so much more than adding something else that makes the voltage go up and down real fast.

If your studio has plenty of sound sources, use modular to reach what you can't reach in a VST and send modulation everywhere. Unless you're hearing something from that new VCO that you can't easily provide from your other equipment and software, you may find yourself held back by it. Think about what can enhance what you already have in the rack. Consider: "What's going to affect the most modules and equipment that I already have?"

Tubes, warmers, saturators, and full analog - Mmmm, analog. Modular offers a lot of opportunities to go analog. Computing gets ever closer to perfect analog emulation, but never seems to reach it. There's something about the hissing entropy of a starved signal, something in the slowly-burning filaments in a tube that can be approximated but must be real to be truly heard. Yes, this is all dweeby audiophile talk, but this is the Composer section. I know you're out there.

Are you looking for a highly specific warming unit with filtering, effects mixing, Eastern European tube clipping, and fully analog LFOs with attenuation, all DAW-controllable through a USB interface? You can build that in Eurorack with existing modules, and in possibly even more formats by the time you're reading this. You need not even build a synthesizer, you can make a dream piece of audio equipment from individual parts like a Frankenstein's Monster of 19" rack equipment. The modular community is often caught up in the construction of something that makes noise, not something that processes or controls it. It's entirely possible to make a "Secret sauce" analog mastering box with USB in-out and no sound sources whatsoever. Let this inspire you if your only goal is a warmer, glued, analog sound: Keep the versatile tools you love and focus on making studio equipment such as a dream compressor or processor that fulfills all of your wishes for such things.

Deep/Menu Modules - The studio is the perfect place to explore, enjoy, and harness the arcane functions of "deep modules." If you don't mind fussing over a tiny screen every once in a while, a deep module can shine in your studio provided that you're not allergic to reading the manual. Even if it doesn't have a screen but bears a ton of buried functionality, there's no huge hurry in the studio to switch it over in the next 4 bars of music. Get lost in the features and learn how to program it like a pro, the results of these "study sessions" will show in your patches.

In fact, when looking at feature-rich modules, there's a trick you can perform when deciding to buy which was not available in ages past: *Read the manual before you buy it.* In fact, I'd go one step farther and suggest you read the manual before you start thinking of including the module in your build (or in popular parlance: Before you

start "GAS-ing for it.") You'll be surprised what you find: From secret reverb algorithms, to clean line-level boosting, to alternative firmwares for open source designs you may find that a boutique oscillator which has already caught your eye can not just offer a few oscillation patterns, but do much, MUCH more.

That said, if this alternate function is a function which precludes it from performing its main function, remember that when it's performing an alternate function of its design it will not be available to perform its original function. Most multi-function modules with the stated purpose of performing one of dozens of functions are not "Like having all of these modules" but more like "Having one of these modules at a time, and a very simple implementation of the function." See the **Multi-Function Modules** section of the Explorer section for more thoughts on buying a module with many stated functions. If you're buying a module for its versatility, have a primary function in mind for it in your system first and flex to its alternate purpose(s) when you get curious.

Virtual Module Platforms - As a purely studio musician, you have an incredibly affordable option for your modular needs. Provided your computer can handle such programs, virtual/software modular programs exist and as of writing there's one that exists for free. These allow you to construct a rack, patch it how you like, and through software these can approximate the dynamics of a full modular system, modules, cables and all, for no money. The drawback of course is that it must be navigated one click at a time so multi-finger flips and sweeps are not an option until these support multi-contact touch screens. The other drawback is processing power: Because a synthesizer can perform endless audio rate modulations all at the same time, you'll need a somewhat beefy computer to handle some of these programs. That said, if you just want to dip your head in before you commit to a full modular system, this is a great way to learn beeps before you burn cash on this hobby. Many of these can function as VSTs so your modular journey may begin and end inside-the-box as it were, and many composers prefer it that way!

One last note on module research - There's demos, reviews, and instructional videos but there is yet another way to be well-informed before purchasing a module to add to your studio. Despite the incredible amount of options a synthesist has for assembling a modular synthesizer, someone has probably paired any two given pieces of equipment with each other already. A search on the internet for any two pieces of modular (or desktop) kit will almost invariably turn up a video of those two pieces of kit plugged into each other. So if you search for the name of your favorite physical oscillator and perhaps a spring reverb you're interested in, you'll likely find someone who's already put them together and you can preview the sorts of interactions to expect from the pairing. Be careful though, because you may find videos featuring these two modules plus some

other modules you've never considered, then find yourself craving a random module you saw in a video once and may not really need. Browse with care!

3. - Equipment Design

Here's a few ideas on how to arrange a case, and utilities around the case, for a studio environment. It's a little light as the best arrangement of modules for a composer is whatever makes the most sense to you as a composer, but we're getting ahead of ourselves. Let's take a look at some of the case considerations which don't necessarily involve which modules you're composing with.

The Big Red Button - When seeking to record compositions which involve a modular instrument of some sort, the time to record it is now. All modular formats are unpredictable. It doesn't matter how long you've been playing, how solid your system is, or how certain you are that everything's saved and replicable upon a startup. After you shut the machine off, whatever noises it's making right now will be at least slightly different. Save yourself the heartbreak: If your modular rack is in a controlled studio space and you've got something magical going, ***record it now.***

To get the best returns from this temperamental, wild world of raw voltages, have the action of recording your modular be a button press away, or at least something that's ready to go in a few seconds. Make this action easy on yourself so you never need to hesitate about hitting the record button in the moment. If you need to run cables, move a laptop, troubleshoot ASIO, and open and close your DAW a few times, that's not easy. Make it easy, and hit record often.

Noise, Noise, NOISE… - Why are you getting such a noisy signal? Modular generally operates with some massive headroom in terms of Volts Pole-to-Pole or VPP. It's been mentioned earlier in this section that not all consumer audio equipment can strictly handle systems with this much range. Despite these abyssal floors and towering ceilings, your noise floor is still a consideration because this wild and humming "analog flavor" is missing the clean, easily processed character of a DAW with VSTs. Keeping your signal clean consists of all the usual studio considerations: Condition your power, physical grounding or lifting pads, not having your studio next door to a gigantic EMF-generator, etc. With modular, however, there's some other stuff to know if you're going for the cleanest signals possible:

Flying buses - These power solutions which are just a ribbon with power headers on it tend to have noise, interference, and power distribution issues which

aren't found on a board that gets mounted to your case. Flying buses work just fine for most applications but when you're looking for immaculate sound quality, tons of modules, and low-interference, nothing has the reliability of a board. In fact, some boards and full-case solutions have noise reduction built-in. But wait! Don't put that flying bus on the marketplace yet…

Mixing Analog and Digital Modules - You can have analog modules patched into digital modules with little consequence. You can even have analog and digital modules in the same case. If they share a ground line, however, modular synth builders have found this to be a major factor in generating high noise floors. Modules share a ground line if they're being handled by the same power solution or are otherwise separated by the architecture of your power solution. A common way around this hurdle is to get separate power solutions for your analog and digital modules. If most of your kit is on one side of this dichotomy with a couple outliers on the other, placing all of the outliers on an affordable flying bus is actually less noisy than having all the digital buzzing on your sensitive analog equipment's ground lines.

Leveling - Best efforts will only go so far, and to be honest electricity is a wild and unpredictable force of nature. It's something that people with Bachelor degrees in circuit design will only tacitly understand and people with a Masters in EE will admit is functionally unpredictable. At some point you'll need to follow your signal chain and level-out your noise floor. The utility of the headroom in modular formats is now apparent: You can find an acceptable leveling configuration across your signal chain that works for your workflow and say "good enough." Stay sane out there unless you love this particular chase. Your productivity will thank you.

Where it fits, it sits - When it comes to a rack arranged for purely studio work, critical thought as to its surroundings is really your best guiding principle for module arrangement. This is because everyone's studio is different and you are the designer of your personal studio and personal case at the end of the day. Maybe you'll need to run the cables out the top because your case is inside of a table. Maybe it's a series of analog utilities that run in and out of the same interface module which is on the left because your case is to the right of your sampler. It's a part of your studio, so take your studio and plans for implementation into account when constructing it.

Total accessibility of all modules at all times without shooing a few wires out of the way isn't incredibly important if you're composing out of the rack and not playing it like an instrument. If you're not using CV to control a lot of those parameters anyway, I'd argue that you're missing out on one of the incredible strengths of modular formats. One time a thick nest of cables protected my dozens of knob states from a cat that snuck

into the studio, so sometimes chaos and occlusion is good actually. Take a step back from where the instrument is going to sit, observe everything around it, and make your plans from there.

Use your best judgment here as I cannot possibly predict what you have going on. Just remember that the layout is malleable and it may need to change with your studio or need tweaking after you think you got it right. Never think of your modular as something that's super-glued into its case. The order and contents of it can be shifted as your studio grows, changes, and moves! If you find yourself really jamming out on your modular setup, take a peek at the last section of the Musician chapter for more tips on how to declutter the face of your synth.

The Generative Ambient Case You Want To Build

"When I started in this scene more than 20 years ago, it was hoped that the extremely-steep learning curve for modular would prevent or discourage people from making bland ambient self-playing patches and just recording it for long periods. No such luck."

*- **Eric Barbour**, founder of Metasonix on Modwiggler.com*

      I love patching up some generative ambient and I see you. You don't want to perform or compose music, strictly, with a keyboard or drum grid or in a DAW. You want to create a case that thinks for itself and gives you that "unattended ambient" sound where you can sit back and listen to your patch do its thing for a while. This sort of music is a little bit of all of the synthesist types at once. Maybe you want to record some of it and fix it up in a DAW, or maybe you want to merge the act of listening and creating music to make your modular experience a bit more random and emergent. This is honestly one of the most exciting and characterful ways to interact with modular as a format. No one type owns it but it requires special considerations all the same.

      The world of generative ambient occupies a space between a playable instrument and programmatic composition depending on how you choose to interact with it once it's wired up. That is, if you choose to interact with it at all! Because this knowledge could apply to any type of synthesist, it is its own section. Herein is a series of findings which outline some specific module types you'll want to consider for this kind of case build, as well as why generative composers and musicians find them important. But first:

Direction and Rules: The Generative Mindset - There are very few rules as to where "generative" composition begins and ends. It refers to a patch which is "self-playing" and makes its own decisions, so perhaps it's accurate enough to say that a "Krell Patch" is the archetypal generative patch. A Krell patch is considered both a rite of passage and a mark of skill among synthesists. A "Krell Patch" is a patch wherein each note has a random envelope, duration, and pitch. Depending on an individual's preferences for this challenge, it can also require that the tempo and meter are random. In namesake, it only needs to sound like the "Ancient Krell music" from the 1959 film Forbidden Planet. In practice it's a show of your technical skills and personal style, like a skateboarder performing a kickflip.

If Krell Music is the "kickflip" of the modular world, I would argue that making generative music in an established scale and temperament is the 720 gazelle flip of modular. Generative Jazz is the 900-degree spin, unachievable to all but the most dedicated and daring. Whether you're shredding on the sidewalk or the synthesizer, these feats require discipline, knowledge, practice, the right equipment, and failing to accomplish it many, many times as you figure it out. Is it worth trying to make a self-writing patch which generates listenable music within the standards of Bhairagi or 12-tone even-temperament tuning? Yes. Absolutely. It feels amazing to make a "living composition" like that. Why wouldn't it?

So how does someone approach composing music that composes itself? By meticulously tuning the **rules** and **directions.**

Think about a generative patch like this: Your patch begins with nearly infinite potential and no sound. Every cable you place can be thought of as establishing **rules** (through attenuation, quantizing, filtering and other "constraining" elements) and **directions** (LFOs, gate patterns, envelopes, "movement" elements which change things over time) for the music to follow. If you don't set up enough rules, the patch will behave in shrill, crunchy ways you may not enjoy. If you set up too many rules which don't change over time, the rules will be too strict and you'll have a stagnating, boring patch. If you're not providing enough directions, the patch won't move enough to be musical, and conversely too many directions will lean towards a chaotic, noisome racket (which may be your goal, noise musicians.) Balancing these two disciplines of rules and directions in your generative patch is key to achieving your ambient intent.

This approach, of a self-generating composition that moves within a given set of rules, is wonderful for people who are interested in music theory. It allows you to approach composition from a point of pure theory without needing to learn the manual proficiency that chord transposition requires of your hands and fingers on a guitar, piano, hammered dulcimer, or any other classical instrument. If you want to compose and perform something which incorporates the Coltrane changes, non-functional harmonies, or avante-garde Jazz techniques… You've got one heck of a road ahead of you in figuring out how to wire up those rules and directions, but you can do exactly that without first learning where to put your shoulders over the piano bench. If you are already musically inclined, this is a great way to make your modular act as the rest of your jam band. When improvisational jazz is a conversation, this is like conversing with your own automaton through music, and I think that's neat. The only musician I'm aware of who's achieving this sort of man-machine jam music is *Lars, Lucy and 8Legions*. (Lars and Lucy are machines, by the way. I highly suggest checking his videos out for

musical inspiration.)

Here's some non-obvious module types which I've found useful for generative composition. You're going to need oscillators, filters, and pattern generators and such. I'm sure that you already have some of those in mind, but have you considered:

Rules (to reign things in from maximalist chaos)

VCAs - To be short about it, running an LFO into a VCA's IN port and an asynchronous LFO into that channel's control port leads to longer, less predictable changes in that LFO wave over time. Change "LFO" to "stepped modulation", "pure random", "sample and hold", or even "envelopes" and you can see how this is where a huge amount of patch dynamics can come from. This is how you leave the grid of a predictable oscillation pattern. No more audible repeats, just flow. Generative music without VCAs is the realm of fringe theory, experimental artists, and masochists.

Passive Attenuators - Some modules have attenuators on them so every inward signal can be dialed down to just the right range from its modulation source. Some only have a few, and most have none of these little attenuator knobs. You can get passive-attenuating cables, modules, and splitters for incredibly cheap. Make sure you can reign in your modulators somehow because it will come up and you only have so many VCAs. Use the VCAs for highly-audible, long modulation patterns and use the passives for utilitarian tweaking and limiting.

Chord Quantizers and Precision Adders - It's easy to think of chord quantizers as exactly what it says on the tin: Plug it into your chord oscillator and enjoy pre-quantized chords. This patch can be handy in generative compositions, but it's the least interesting way to use one of these quantizers. The V/Oct information from your chord quantizer is harmonically-relevant intervals which don't necessarily need to go all towards the same destination. If you tune several tonal elements to each other, perhaps across several modules, your chord quantizer isn't just making chords anymore. It's making cascading tonal changes across your entire composition. By tuning an oscillator one or two octaves lower than the others, it's going to follow this rotating chord, but remain as a bass element which will help when you're trying to mix it. If you combine this technique with a few precision adders, you can use the chord quantizer as the base note while also sending a note sequence to the same destination. Subtly shifting these rules of what chord the whole band is playing in, moving from minor to major to more complex chords, is the easiest way I've found to generate conventional, emotionally-evocative music in the Western canon upon modular sound equipment.

Function Generators with Logic - Some modules are made with the express purpose of generative music applications. Function generators are not, but they might as well be. The CV-able application of slew and modulatable envelopes are neat but most multi-function generators (with two or more function generators) also include additional gates and CV-outs for state-specific values. These can be gates that trigger on an envelope fall state, turn off when one function is greater than the other, or CV of the difference of the two channels at any given time. Random events are easy to achieve in any modular case with a noise source, but "steerable random" can be hard to find and tame into something listenable. With some creative patching, a modulation matrix that's steering your patch can use a function generator to produce controllable random events. If you'd like shorter, less rare gates for percussion then you need only dial in your sweet spot. The difference between two functions that are already being used for stereo panning can be used to pan a different element to create converging, related stereo sounds. The harder you think about a function generator's use in your patch, the more it will give you. I personally feel that the skill of a synthesist can be defined by the sheer number of amazing things they can make a function generator do. These modules patch well, self-patch very well, and reward creativity, so in this case only of generative case construction I'd suggest you consider adding one even if you're not 100% sure what it'll be used for yet. Function generators can be used to set rules AND establish directions. On that topic:

Directions (To keep things moving within the rules)

CV-Able Envelopes - The difference between a pluck, wash, and blip is all in your envelopes. Giving generative patches an envelope to modulate will change the timbral character of an element over time. Instead of easily-identifiable beeps from the same module throughout your track, modulating the attack and decay on an ADSR-envelope will turn that element into a floating, high-character element. Even classical guitarists don't hit the string the same way every time. Vary it up.

LFOs and other Weird Modulators - If there is any one rule of generative patching, it's "move slowly but keep moving." This applies to everything in your patch for generative applications, and the more things being modulated by the modulation matrix you've set up, the more "generative" it is. The difference between a pleasant minute or so and a vast, unpredictable, wandering soundscape of a patch depends on how many things you're modulating in a unique way over a long period of time.

DC-coupled Matrix Mixers - Besides being one of the many things you can sing to the tune of the Teenage Mutant Ninja Turtles theme, matrix-mixing your CV signals is one of the fastest ways to introduce a TON of motion and direction into a patch from a

handful of signals. If the levels on the module you are using as such a mixer are also CV-able, you might be sitting around for days and never hear a pattern repeat. Really anything that lets you mix, fold, and mess with other CV signals is your friend in this respect.

ASRs - Analog shift registers are one of the oldest and enduring concepts of generative patching. These are like a sample-and-hold with four outs that remember the last 3 "held" values as well as the current one. When a new trigger captures a new state of the sampled modulator, all the existing values are pushed across its other outs with the oldest value being lost. This allows sweeping rises and falls to cascade across several parameters and modules as the clock advances on these captured patterns of CV. If you have complex oscillators in your case with very characterful knobs which change the whole sound of the module, ASRs are a great way to manage several generative, drastic changes to its elements such as envelope lengths, timbre changes, and preset selection.

I look forward to hearing your generative ambient. It's like a sport within the hobby that originally drew me to modular. May your patch notes be incomprehensible!

The Path of the Fancier

"If you want to find the secrets of the universe, think in terms of energy, frequency and vibration."
- Nikola Tesla

1. - The Human and the Hum

Sound isn't just about music, is it? Don Buchla and West Coast design always seemed to put music last and the spirit of analog circuitry first. Even exploration isn't quite what you're looking for, as a new sound is novel but it isn't necessarily profound. Perhaps you're interested in the alleged effects of binaural beats, or experimenting with custom noise fields for Ganzfeld effect experiments. Dynamic and alien spectral stereo soundscapes are a wonderful accompaniment to meditation. An individual's worship of sound may run even deeper than that with a specific circuit's sound relating to personal nostalgia, acting as a link to the past of making sound itself, or making a personal connection to feelings of the divine. Heck, maybe you're into… let's say "individualistic experiments with unusual mycology specimens" and you'd like to make a companion device for those forays inward.

If so, this section is for you. We're not in the realm of tempo, scales or temperament anymore. "Fancier" may sound like an effete label for this kind of emotional, subjective, and extreme sort of sound experimentation but Fanciers are anything but timid. Wave-worshiper, sonic monk, and sound summoner are all fitting titles for members of the Fancier discipline, but at the end of the day it's about fancying sound itself over the notion of musical constructs.

One time, at a synthesizer convention, I found myself at a private jam room that was running throughout the event. A good friend brought their 5U system. It was a massive thing with all the usual modules you'd find in a modular system. After some time, they turned it on and patched a single tone to the shared speakers. Upon doing so, they carried on a conversation with a friend nearby, occasionally tweaking things about the phase or waveshape but it was just a constant, running high-pitched tone. After twenty minutes or so, the person running the room asked them to please make it do anything else. The system's owner apologized and realized that they never turned on the sequencer. The sound of that same tone that filled the room for 20 minutes, now moving up and down between two notes, was funnier than any joke I could ever tell. The humor of the situation aside: I gained an odd respect for that synthesizer's owner.

Up until then it was all about a warm hum on a triangle wave.

It's true: Fanciers will patch for hours on end upon what amounts to a single tone. Digital is not an option when the goal is experiencing the naturalistic circuits of a pre-digital design. A fancier does not seek to make "noise music", they seek noise itself. This section describes the steps for making a case which is post-musicality. A system of unpredictable components, unusual synthesis methods, and nontraditional output. It is physical in an increasingly digital world and pulls you away from a screen. A Fancier's system can even be therapeutic in a holistic sense.

This section provides general guidance for non-musical artists in designing an inspiring and satisfyingly complex instrument beyond expectations. "Exploration" as in the Explorer discipline can be a factor, but it's closer to a spiritual and emotional exploration. Explorers are here to engage with the fun and complex world of synthesis, Fanciers want to engage with what is ultimately the physiological effects of non-traditional synthesis. This section is about granular audio introspection, musique concrète. sound sculpture, and analog worship tools. Synthesists who are so far West Coast that they're actually closer to a beach in the Wakayama Prefecture, this is for you.

2. - Building an Atelier

In terms of module selection, Fanciers follow an entirely different discipline than the musically-focused synthesist types already covered in this guide. Here's a few things to think about when selecting modules for your most unusual endeavors:

Oscillators:
Fanciers have wildly different needs for oscillators than any of the other types. Musically-tuned complex oscillators and full drum voices are obstacles in a Fancier system at best. Some Fanciers' instruments are fashioned to resemble a historic or nostalgic design, but their enjoyment of such things comes at the condition of a highly specific, often analog character.

There's three things that Fanciers should consider when considering oscillators for their designs: Analog, TZ, and Sines.

Analog is analog. For everyone who says they cannot hear the difference, there is someone who insists that they can. For many, analog represents more than an expression of audiophilia or even something which can be proved in a taste test. Analog circuits commonly represent, to a Fancier designer, the antithesis of modernity.

Synthesizers can offer a personal, spiritual sort of escape for their players by virtue of being analog. I feel like I can hear the difference, but who's to judge when the goal is not music but happiness? Analog is not required to achieve naturalistic tones, but it still holds value as a holistic design choice and a total departure from pervasive, digital audio limitations. If you desire analog signal paths, they're worth considering.

TZ refers to "through zero". The position of these oscillators' waveshapes dip them in and out of negative voltage in a single full oscillation. This crossover generally lies down the middle of the waveshape. These negative frequencies are used by other synthesist types for bi-directional modulation and constructing heavy bass tones. At audio rates, it's audibly a little different particularly once you start messing with the wave. These TZ noises are deep and guttural, evoking atavistic sensations and audio hallucinations in certain patched applications. TZFM, in addition to being the internet's answer to the Flavian Amphitheater in terms of watching people fight over synthesizers, fundamentally changes the audible character of FM. Remember that the precise divisions of FM required to maintain familiar, harmonic ratios are of no importance to someone intentionally wandering the audio roads less-traveled.

Sines so often take a back seat to triangles. Pure sines do not respond to a filter's hysteresis, creating those pleasing timbral shifts in every popular electronic music subgenre. Most filters function as a volume knob for a pure sine. Generally sines are only an ingredient of FM and modulation for other synthesist types. Really though, sines are the most natural tone. Vibrations on a molecular level are sines. Church bells and their deep, awe striking tones are sines. Those low, even hums can be waveshaped, FMed, and distorted in artificial sounding ways but there's something demonstrably natural about those smooth vibrations. Explore sines, and make sure that whatever oscillator or oscillators you incorporate into your design are ready to output numerous, satisfying sinusoids.

Granular Modules - Granular modules are one of the most fascinating ways to appreciate a sound. Granular processors grab tiny snippets from a region of a sound and re-scatter them across an audible spectrum. They're digital, but I find that one can nonetheless become lost in browsing the microcosms of larger sounds. A recording of a drum, someone's voice, or other recognizable raw material will inevitably take on a new life when granulated into a glittering soundscape one microsecond at a time. Microsound and Lowercase artists may inevitably find themselves drawn to these for their concept alone. Reach for these when sculpting a meditative drone to add complexity, or taking a listen so close to something recognizable that it becomes alien again.

Tape, Virtual and Real - Tape is another commonly fetishized accessory to sound, and there's no wonder why. The compressing "glue" that a tape transfer adds to a mix is sought out by mastering professionals, yes, but that warmth represents the properties of something real and material. Tape delays on real tape are not easily synced, but syncing to a beat is largely not the point for Fanciers. An audible signal on a tape loop (or tape-style loop) has influenced countless experimental artists ever since reel-to-reels arrived in music studios. Placing a tape machine of some sort, even a simulated one, into your system design ensures that this popular and powerful tool for making artistic statements is just a patch away. It can also serve as a way to slowly build drones from smaller components, each progression adding to a rotation of the tape in a slow approach towards deafening maximalism. Sending the out signal back in as a processed re-dub results in Alvin Lucier-like effects where each incarnation of the self-rewriting loop becomes less recognizable than the last. Truly, tape machines have hypnagogic potential beyond just recording things. Now, on the topic of recording things…

Field Recorders - This can apply to any module which allows your synthesizer to listen and react to the world around it: Microphone interfaces, EMF detectors, light sensors and more. Fanciers who seek a "material" sexperience from their synthesizer may enjoy giving their instrument some functional awareness of the world around it. Recording leaves in the wind can be one step of a granular exploration of those microsounds. Birdsong amplified into triggers for a function generator or slew limiter turns the rhythms of nature itself into an envelope source. Bring the world into your instrument, and enjoy the new worlds that pop out.

"**Gimmick" Interfaces - Brainwave Detectors, Heartbeat Readers, Movement Sensors, Plant Interfaces, Fidget Spinners, Etc:** These sorts of modules are basically meant for Fanciers. Each one redefines the human machine interface into something quasi-medical, hyper-futuristic or dare I say it: Fun. Large fields of touchpads, video game controllers, the list goes on and they're all interesting. Keep in mind before buying how you would like to interface with your modular, but what does that even mean? Wel;, here's an example:

I'm a fan of placing a piezo mic inside of small, portable systems so the case itself becomes a drummable, percussive accompaniment to the modules inside of it. Pairing this mic with a resonator, gate extractor or amplifier means I can walk around with the case, letting it buzz with every step and ping as I tap my fingers on it. With a function generator I'll dial in a short attack and a very slow decay on this signal so the general amount of agitation adds up, allowing me to bother and even "anger" the synthesizer if it's jostled too much! This approach of walking around with a

battery-powered, piezo-sensitive system goes beyond joystick control, and relinquishes part of the man-machine interface to physical activity. With some creativity and inspiration, you can come up with your own patches or new modules that redefine how you interface with your instrument. There's a whole world beyond patching cables and turning knobs.

Oscilloscopes/Video: Visual output can be just as engaging as audible output, and is yet another way to turn your rack into a multi-sensory experience. In terms of racks which exist as an art piece, this multimedia approach is a great way to help it pop in a gallery setting when given some way to display or project this video content which the music ties into. I find it pleasing to use mults that clone my most noticeable CV signals in the audio mix, then run a copy of them to the visual output in some way.

In terms of oscilloscopes, prolonged creative patching for creation's sake will invariably lead to something cool on your scope. Scopes with an XY mode can be used for oscilloscope art. You don't need to be Jaroslav Fenderbeam to enjoy scope art: I've had a drone jam going and I looked over at the oscilloscope to see a spinning lotus flower. The patch from then on was all about spinning, turning, and floating the flower as well as making it bloom! Much like Explorers, visual feedback is another way to experience your output. It's not a cheap arena to enter if you're not soldering-up your own video devices, but remember that there's analog video synthesis to consider as well when constructing your multimedia sensorium.

Format Jumblers - These are very quirky beasts which convert signals to operate under a different modular standard than the one you're currently using. One common type you'll see bridges a TS cable based system with a universal grounding scheme to an ungrounded banana-jack system. Swapping the signals of what you have through two kinds of formats is yet another place to discover the analog strangeness which emerges from these worlds colliding.

I've seen a few other ways format jumbling has been accomplished in spirit if not literally: Designs which were meant for one kind of system are sometimes lovingly recreated in another. In other cases, I've seen modules which exist to host a whole discreet device from another format, thus creating a 2-format module which can also serve as a jumbler. All of this crossing in and out of these separately-designed worlds of synthesis can place a haunting, vast character upon your tone. It imparts a feeling of "Woah, so many synths" as all those distinct sounds come together.

Looping what's on your music table into what's in your modular case at first sounds merely utilitarian. It's actually a great way to get fundamentally different timbres

into your most versatile format for processing them.

Wavefolders, Distortion, Bitcrushers - These are three ingredients for making swirling drones. When you're looking to make raw, noisy, harmonically-devastated drones: Slowly folding a wave, distorting a wave, and bitcrushing it (in any order) are effective ways to draw the "ghosts" out of your sound. Not literal ghosts of course, but the audio illusions which catch the ear differently for every listener. Expect to hear some truly gnarly output from this 3-ingredient magic spell. Lean into its extremes, modulate it, it's devastatingly raw and fun to explore. Oh, and remember to add...

Reverbs - For once analog isn't necessarily the best choice here. I know, Fancier system design is a largely emotional experience and it can feel weird having digital representation anywhere in your church of analog worship. When it comes to reverbs, the analog options you have are a spring reverb and actually performing in an empty hall. Spring reverbs add a lot of character to a sound, and work for short trails, but they're not known for being particularly "vast" sounding.

Maxed out digital reverbs open the pit where complex, abyssal drones crawl from. Modules with experimental and complex stereo reverb algorithms go beyond the usual illusions of space. Unusual, noisy, droning sounds build upon themselves on near-infinite reverb trails to create shimmering, trundling and ethereal soundscapes. It's difficult to explain exactly how this all sounds, but digital reverb algorithms are finely tuned by their incredibly talented designers to sound smooth and realistic when given traditional, musical sounds to process. When processing the raw, experimental tones of a Fancier's system, the resulting sonic slush is like peering out over an alien landscape. If you're looking to add cosmic-scale gravitas to your system's sounds, go big on your reverb, and it may pleasantly surprise you.

Outs - Headphone adapters are good, and are probably what you're thinking of getting, but consider the output of your system with the same creative ardor given to all of its other contents. Quadraphonic output, for instance: It's something generally avoided in modern-day music releases, but its historic appeal which harkens to the golden age of synthesizers may also appeal to you. Since distributable music is not the core goal of a Fancier's system, you can enjoy live-synthesized quadraphonic sound by simply facilitating four speakers in your line-out module or modules. Beyond serving technical nostalgia, this is an often-ignored opportunity for creativity in how sound leaves the case. Consider how the sound should reach the listener first, then decide your outs section around that.

LFOs and other modulators - Creating motion in your patch is imperative to making

sounds with a spark of life to them. Multi-modulators, interlinked lfos, and arrays of smooth random signals are great choices. If you find yourself running out of any resource in your case, it will likely be modulation sources and modulation points. You'll have plenty of knobs to tweak so remember that the spark of life in a patch, where it feels like the synthesizer's speaking back, comes from building an inscrutable modulation matrix.

LFOs that can reach low audio rates have a different, exciting use: Binaural beats. If you're looking to wire up some binaural beats in your case, I have a personal recipe for them which I'm glad to share: Tune two audio-rate LFOs by ear so that the sines sound like a low rumble. Keeping it under a 30hz difference, but still with a difference, can be accomplished on accident in this way. For ease of use, mult a static voltage source to the FM control for both so you can control both frequencies with a single knob. Keep all of this in mind when looking for your LFOs if you're hoping to make binaural beats. I suggest finishing off this patch by dropping the sines through zero and giving them a lush, digital reverb. From there you can sit back, clear your mind, and enjoy the ghosts in your machine.

3. - Keeping It Complex

As in previous chapters, there's things to consider about your instrument which aren't related to module selection. On that topic, there's not a lot I can say or generalize about in this chapter! When your case's design is about free expression, there's very few rules to follow. Still, here's a few seeds of inspiration to inspire your brain-ship's control panel.

Manufactura Obscura / The Other Tape: While reading Marie Kondo's book "The Art of Tidying Up", I came upon an unusual tip which amounted to: "Use washi tape or masking tape to cover up the brands on the contents of your pantry." Really, brand names and branded colors on household goods are advertisements which persist after your purchase. Naturally I turned to my synthesizers, which are sometimes "egregiously branded". I've seen synthesizers with brand logos on the chassis for the synthesizer company itself, the filters inside of the synthesizer, one of the control methods, and the specific sort of MIDI implementation inside of it. That's a lot of ads!

My drone instruments are very much objects that spark joy, and became something of a tool of worship for the odd, audio reaches they could take me to. Would there truly be a point in going over them with some masking tape to just cover up the brands? I knew who made each device by heart, even the name of the person who had

designed and assembled this one's bucket brigade delay, so what could this possibly affect? I resolved to try it anyway and was pleasantly surprised: I did feel an odd purity of purpose from it. These devices, with the brands covered-up by masking tape in a color resembling the chassis, took on a different sort of visual life. There were no names or makers, no incomplete ecosystems, no online opinions about their interiors or history, nothing except their sound. They felt like new devices… so I went further.

As synthesists we can sometimes fall under the effect described in Mark Twain's "Life On the Mississippi", where the might, majesty, and magic of a synthesizer are dull and utilitarian after our love for them has led us to *understanding them*. So few knobs are a fun mystery anymore when we inevitably become experts at synthesis. With a bit of meticulous placement, you can tape over not just the brand but the functional labels under your knobs. Even if you remember what a given knob does, decoupling the knob's label from its actions provides another level of disconnect from the finite feeling of a well-known synthesizer. To help your modular sound machine feel a little more otherworldly, tape (or sticker!) over the brand names printed upon it. Tape over the front panel labels if you'd like to take this feeling even further. It just takes a bit of masking tape, so why not give it a try?

Mind the Summoning Circle: When deciding where to put your synthesizer, as a Fancier, remember that it does not need to stay in the studio or sit strictly where your studio demands it. Try placing it by a window you love, taking it to interesting and inspiring places, or moving it to whatever non-studio room means the most to you. The right placement results in your modular delving device having a better spot for its purpose. The area around your synthesizer, once you've found the right place for it, can then be decorated in a way that presents your instrument as something more than just a synthesizer. If it suits you, find an "altar mat" to place underneath it, place some meaningful stones in its periphery, or locate a singing bowl to sit beside it. Those bowls are a meditation tool in their own right which can be recorded and put into patches!

Just be careful about burning incense near your modular. Smoke has been known to damage some of the more delicate components of modular synthesizers, so burn that cone and copal in another room or you'll risk prematurely wearing out your vactrols with patchouli smoke.

Forests of Chaos: When it comes to arranging your modules within the case they are given, it's entirely an exercise left to the designer. Famously, when designing his own instruments, Peter Blasser took circuit board inspiration from buildings and societies he enjoyed visiting as a child. Creative arrangement can take the form of checkering your light and dark modules, reproducing constellations with large and conspicuous knobs, or

following really any concepts which are visually appealing to you.

One of the most interesting design ideas I've seen is placing a lot of small modules very close together so as to intentionally make a whole area of the synthesizer hard to access. Once these dense areas are filled with cables, one must go in there with tweezers to turn any of the knobs. While this is aggressively anti-playability as a design choice, it creates pleasing nests and pillows of cables along the front of the device. When your modular synthesizer itself is a sort of holy object, it makes sense to lean into this discipline of hyper-dense cabling and precision tools as an aesthetic choice. Cables are an emblematic icon of modular format synthesizers, why not celebrate them somehow?

The Path of the Collector

1. - A Dragon's Treasure

We're here today to talk about the shiny modules. Not necessarily the music they make, that's cool, but I mean the modules themselves. In popular closed formats there's either a full range of modules with tried and true designs, or each one is a small piece of rock and roll history. In open modular formats where anybody can contribute to them, the number of blinking, futuristic, lavishly decorated little squares is literally never ending. There's tribute designs, clones, bespoke modules, stuff to make, stuff to try, and incredibly limited runs of modules which by their own admission are bad ideas. It's incredibly easy to get caught up in it all so… You're just kinda collecting this stuff now! You want more.

This chapter is for the modular instrument makers who are looking to go big. Perhaps you've made a little music but discovered that the collecting part of modular was more satisfying than the composing. Maybe you want to make your own "Tonto", with usability being second to size. Are you looking to fill a small office with modular all across the wall like JunkieXL? Perhaps you started as an explorer but began collecting more and more modules, and now you aren't sure where the collection's going to stop? There's exciting new designs every day that synthesize a little differently than the last one, and tending that garden could lead to a fun system someday… right?

Are you looking to make a single-manufacturer system? That's also being a collector: For collectors it's about the modules first and their output second. No other oscillator will do, it must be a Brand-X oscillator. This isn't about "clout" or even about showing off: It's about making a system that makes you happy.

Granted, you do still want to wire these modules up. Really, you would like to start patching right now but it's difficult to play a system with 7 options for every single function. Each function is hiding somewhere in a random part of The Wall. Is there a

way to have your 27U cake and play it too? As you might imagine: You can.

Collectors are a large reason for why this guide exists at all. As of writing I've assisted nearly two dozen synthesists with reigning in huge systems and picking the right modules to turn a collection into an instrument that fits their goals. I call the service "Rack Rescue." My happy customers have turned masses of modules into mighty walls of sound. If you're on your third case and wondering why the music isn't falling out of this thing already, that's where I come in. There's no replacement for having an experienced modular system designer take a look at exactly what you're working with and align the instrument with your personal goals. That said, in this chapter I'm going to tell you all of the guiding principles I've utilized so far to turn these massive, hard-to-manage systems from a crowded nightmare into a Tangerine Dream.

This may be a little tricky, see, almost nobody is just a Collector. They're generally a bit or a lot of a Collector with a shade of something else. Perhaps this all started because you wanted to make planetarium music. Perhaps you originally wanted to loop this into your DAW and somewhere in the module hype you got lost. Maybe you wanted to play live but now you have the largest collection of modules in Mendocino County and you can't exactly ship this beast to the local brewpub for open mic night. Making a huge modular "work" starts with establishing your intention as to what a "working" state would be, but I also have some general advice that can help move your modular mountain in any direction you like. Enough talking about theory, let's talk about modules!

2. - Filling Up the Treasure Vault

Curating your collection, and the massive system which contains it, is a discipline of its own. Buying several dozen modules and racking them in a huge case does not necessarily result in a playable or enjoyable instrument. Much of collecting is following your fancy, chasing something new and shiny, or tracking down rare modules and systems in the name of a greater system plan. Here's some commonly overlooked types of modules which may not be in your plan, but will set solid foundations for a large system that's frequently changing. I don't need to tell you to get that dream LPG with tubes from the sunken laboratories of Atlantis, personally blessed by Thom Yorke in an esoteric mountaintop ceremony. No, these are the modules you may not realize you want:

Mixers - Here we are again with mixers as the most important consideration of system design. The sound needs to come out somewhere and before that it needs to end up as

a mono signal or stereo pair. It seems easy: Get a big mixer with a spot for everything. Once you do that, it's connected by waterfalls of cables that stream up and down your instrument and obscure everything. You haven't seen the screen on one of your complex digital oscillators for weeks. There's better ways to go about this…

I've found that the best solution for managing mixing in a large system, particularly tall systems, is a thin, contained, vertical mixing arrangement. Why am I talking about this case arrangement stuff if we're not in part 3 of this chapter yet? In this case, the arrangement and modules go hand-in hand. Some mixing modules represent part of a mixer and daisy-chain with other mixer parts from the same brand. Some have a custom connection cable on the backside of the module or a powerboard-channel clock bus that runs behind the panels entirely. Utilize these stealth normals in designing a thin, long mixer that spans the longest axis of your case. In terms of Collectors who are building upwards in tall cases, this will generally take the form of a "mixer spine" in the middle or on the sides of your setup. For long cases, your mixer should be something wide or several modules interlinked to grab sounds from all the parts of your modular wall. All the parts, that is, but not every single module…

Mixers pt. 2: Channels and Size - I emphatically advocate for having less mixer channels than you have sound sources. Naturally you'll want a lot of channels for drum mixing or layering sounds, but leaving yourself with limitations inspires creativity. Having an oscillator with no clear destination might lead you to try some FM tricks with another module, run it through a complex voice's Noise-In port, or explore its alternate modes as a modulation or effect source. That's a much more interesting patch than running all 35 things that make noise in your system directly and cacophonously into the output. When would you ever do that?

Consider it this way: Think about Star Wars: Episodes 4,5, and 6. Now think about Episodes 1,2, and 3. Ok, now think about episodes 7, 8, and 9. A limitation, really any hard wall in your design that tells you "no", is where creative thought flourishes. Unlimited resources lead to less-inventive thinking as your first whim is made law and thoughtfulness is cast aside. Consider that all of your desktop boxes at once are never as useful as a careful selection of tools which are needed for a given track. Mix your drums in as detailed a way as you like, but don't give yourself too much mixer for everything else. Aim for less channels when in doubt and have it span the long side of your case as a final destination for patching. Layer your synths because that sounds great, but they never need to be all-singing, all-audible, all the time.

Switches - Huge cases benefit from switches in ways that small systems cannot. Think, for a moment, how CV-control is like turning a knob at the speed of voltage itself. It's like

a phantom, automated hand turning the knob for you. Switches are like that, but instead of moving knobs they move cables.

In essence: What applies about CV and knobs applies to switches and cables. You (probably) cannot turn a knob at audio rates, but CV can. You cannot instantly repatch a cable on every 4th beat but a switch can. Large systems in particular harmonize with switches because you can create subpatches of sources and destinations which flip between each other. The massive, generative, self-playing patches you see on video sharing sites will change the filter, timbre, and effects upon familiar elements as the patch goes on. Automate your repatching all over the system and enjoy the sonic variations. It's one of the major benefits of a huge setup, and a downright listenable way to incorporate a lot of kit into a single mix.

Power - Something to consider about your power setup: Do you really need to turn everything on? Isolating your analog and digital modules on different power sources is probably a good idea to reduce your noise floor, but think critically of the large-case mentality where everything turns on every time. Do you always use everything, or are there definite subsystems which get ignored during a session with another subsystem? Power grids which are stepped, isolated, or in a different case entirely will save your less-used modules from a startup surge when they're not needed. There's a few large systems out there which aren't a large, contiguous field of modules for this reason. They're a collection of smaller, independently-powered cases which rely on…

Ins/Outs/Pipes - If your case is large, you're the person who needs these. Input modules let the rest of your desk get into your case and output modules let your case interface with the world once again. They're strictly more important than having "pipes", but in huge setups piping modules are worth considering. When I say modules which serve as "pipes" I'm referring to proprietary module-to-module connections, usually over format-non-standard cables, which move a large amount of signals from one part of your case to another. Signals go in the in module, and out of the out module. From distributing clock signals to routing your submixes, this is how you can create "back holes" in your large case design: A module that's next to a pipe is now effectively next to all of the modules near the other end of that pipe. This sort of module solves so many of the challenges in modular system design that they're almost like cheating.

As a general piece of advice for using a pipe in a large system, put your pipe near your modulation section. Let your mixer handle audio, the CV maelstrom needs to go everywhere. Pipes let you effectively put your modulation section next to everything.

Duplicates - When should you buy more than one of the same module? Most collectors

want variety all across the case, but there's also systems which use backs of the same module to perform more complex operations than just one of that module could provide. When is a good time to get a duplicate, or a whole bank of the same module for your large instrument? For collectors, there's three reasons to do this:

Compatibility: Some modules follow a shared protocol which normalize them to each other. Some examples of this are a mixer that daisy-chains into another mixer, or a modular gate and CV ecosystem that share a clock along a power rail with other modules just like it. Going "under the panel" for normalled modules under the same brand is, for collectors, always a good idea. Large systems quickly become covered in cables and bridging space with a bunch of displaced modules (which effectively serve as pipes) is a boon to the interconnectivity of your large case. If you like the manufacturer of these kinds of modules and want to get into their ecosystem, I'd say these are worth incorporating into your collection.

Firmware: Due to the open source nature of a module, your hybrid or digital module has an alternate set of innards. If you change the firmware on a software-based module, it's basically a different module on the original's platform. Digital modules receive these sorts of updates all the time from their makers or dedicated communities. Sometimes you'll find that these new firmwares are exciting, but there's still the qualities of the original that did other functions better. It's a "duplicate module", but a different firmware on any module with modifiable firmware is functionally different. That's not really a duplicate.

You want more: Sometimes a module doesn't have enough ins or outs. Maybe you like one module so much that you wish you could use it twice. It happens. In this case, expand slowly. New modules will happen in any actively-supported modular format, and something may be on the horizon which better-represents whatever fascination you have with this one useful module. Go one at a time: If you feel there's not enough of this one module, and no other module will do, add just one more.

3. - Managing the Hoard

Designing a good small system is challenging and designing a good large system is, unsurprisingly, even more complex. When I serve as a consultant for synthesists who are looking for guidance in designing their systems, it always comes down to taking their *collection* then designing a *system* from it. Simply placing all of your modules in a rack as you buy them will result in exactly that: A bunch of modules. Everyone's system should be suited to the user and so each individual instrument is different, holding

interesting goals and new challenges for its designer. This section serves as a list of my most useful and recurring guiding principles when I'm turning "a collection" into "a system." While there's no true replacement for peer review from an experienced system designer, it's my hope that the personal voice of your system and all of the goals you have for it can be achieved on your own. Really, following a few paradigms in terms of module placement can turn the large unmanageable beast on your synth table into the mission control panel of your dreams.

So without further ado: Here's nearly everything that I've learned from bringing about that chaos-to-control transformation so many times…

Module Placement For A Cohesive, Giant Modular System

The Human Interface: It's likely that you want to actually play this large instrument in an instrument-like way. How can you arrange a large system's modules in a way that they can be played comfortably? Some will inevitably wind up at the top, but put your interface devices at the bottom.

Generally, when you find a large modular system, you'll also find the modules which allow for direct control are down low. I recommend this! Large systems benefit greatly from having these control modules (sequencers, touchplates, joysticks, modwheels, etc) on the bottom and facing upwards. It functions like the keyboards, drums, and guzhengs we're familiar with as instruments. There's a natural instrument-like ergonomics that humans keep gravitating to and leaning into it will definitely help your system feel more like an instrument. Designating a control row will help you keep your hands and arms in this low "instrument position" most of the time, as reaching up and out for an hour isn't exactly comfortable. When considering what to put low and what to put up high, don't place every controller on the bottom console just because it's a controller. Don't just put your "favorites" on the bottom either. Instead, consider how long you'll be touching or using it while jamming, and ask yourself if it's a "control".

If there's any wavefolder or complex oscillator which you love to twist the knobs on while playing, that's a control on your system. Are you exploring through a new multifunction? You'll be using that a lot. Place it in the row you can most comfortably control and see clearly. Remember: This is the keyboard, drum head, plectrum-like control panel. Everything above it supports and is informed by it, but you'll be playing with this part.

A note: These control rows benefit greatly from a "pipe" module since they're

going to be patched so much. Instead of covering your whole instrument in cables, pipe your control connections with one cable right into the center of your system and you won't need to run scores of cables from the table to the wall. If the center doesn't work well, place the pipe module wherever makes the most sense given the location of your VCAs and sound sources. On that topic…

Cascading arrangement Your control panel is in-place, so what do you do with everything else? As mentioned above, your first order of business should be establishing your mixer bank. Spreading out your submixers in a way that provides "direction" for your signal is essential. When I say direction, I'm more or less referring to classical synthesis paths. Cascading arrangement puts sound sources on one end, mixing and outs on the other, and makes a path for sound to follow in the middle.

A "cascading arrangement" style places sound sources the furthest from the mixers, followed by modifiers like wavefolders and filters, then modulation and VCAs, then effects, and then finally wind up by the mixer. If classical synthesis isn't to your fancy, this same approach still works for the more unusual approaches to synthesis. In the case of non-classical synthesis *you* designate what category your modules embody no matter what it says on the panel. Do you have a tape-style looper that you use as a sound source? Place it far from your mixer. Order is also yours to determine; If the way you process signals is through a lot of effects until it's analog mush, place those effects by your sound sources. In fact, speaking as a drone musician here, you can swap around the places of your modulation/VCA, effects, and modifier/filterbank area to set a natural path for crafting rich, droning textures instead of single notes which then go to effects.

Going with any sort of modules in any order you like for these categories can help make your system unique, but what you're ultimately establishing is the steps patch cable must pass over on its way to your speakers. Creating this direction, from source to outs, allows a more linear way of patching that gives your machine character and, well, direction! Instead of having all your modules in random places, your order and arrangement here suggest how your signals cascade across the panels. The only remaining question is: "Once this is established, where the heck do you put your 8-part logic-driven drum section?" Well, this section is on how you turn your entire huge system into a single, cascading entity. That drum section is a "subsystem", which can have its own gradient arrangement, and with that we're moving into the higher organizational tier of module placement.…

Subsystem arrangement "Subsystems" are collections of modules which perform a discrete function by way of being grouped together. This is your samplers,

sequencer, and mixer section. This is your mastering and spectral EQ section. This is your output-normalled mixer bank. This is your control module skiff set below the towering wall of sound. This is your huge, matrix-mixed logic section that you use as a trigger and modulation source for everything else.These are *subsystems*!

Subsystems are almost separate devices in their own right, as they have ins, outs, and purposes assigned to them. These "systems inside your system" are honestly what make a complex system enjoyable and understandable. Arrange the modules within your subsystems according to the "cascade" placing described above, then place these subsystems in a way that they can reach each other all while cascading from their input section to their output section.

Case Size, Blanks, and "The Buffer" - If you are using an actively developed or open-source format for modules such as Eurorack, get a case that's larger than your collection of modules. Whatever your plan is for arranging your modules, leave some space. You'll refactor, buy, sell, and have a fascination with something new or rare. Blanks can be plain, blanks can be artful, and blanks leave you with a system that feels full but leaves room for adjustment. You don't need to rack everything all the time of course, but leaving room to grow helps you refactor when you feel it's needed. When adjusting your case, keep in mind a threshold of space units, e.g."40HP", which are not planned parts of the system but "flexible" parts of the system which support new modules and future design needs. Think hard about what gets to leave this proving ground and join the system proper, as it will need to kick something out which is already a part of the system in order to fit. You worked hard to get the gradient arrangement of this subsystem together. Maintaining the idea of this "buffer" space when making small redesigns is your defense against messing up the order.

Subsystem Harder with a Vengeance - Some of these subsystems can turn into a whole new obsession. You'll find that each new module you're getting is in service to this subsystem and it's starting to disrupt the integrity of your larger case. When this happens, it may be time for that subsystem to go solo. Having everything in one case is nice, but at some point, you're now working on a completely different instrument, not some smaller part of a whole larger system. Place these subsystems in their own cases. Once this subsystem has the boundaries of its own case to answer to, you can fine-tune this design on its own instead of keeping its space and position beholden to the greater part of your collection in the "main" instrument.

Single-Manufacturer Systems - These sorts of cases represent the collector type better than any other sort of system goal. "Single-manufacturer systems" refer to a modular system with the goal of containing only modules from a single brand or

designer. I've spent considerable time with some of these and, I admit, these systems are interesting. That's truly what they are: Interesting. If you have a particular fascination with the designs of a given maker, this is a way to support them while immersing yourself in their values as a designer. Using an unusual system entirely designed by one person allows the user a parasocial window of sorts into their creative mind. There can be a fun, alien feel to these systems akin to playing any system designed by another person.

Hold on. Before you attempt to make one of these, you need to know that I constantly see them short-circuit people's impulse control.

In making a system with the sole purpose of "containing a particular set of products by virtue of their brand or origin", you've created a system where the goal is buying more modules. If G.A.S. "Gear Acquisition Syndrome" or F.O.M.O. "Fear Of Missing Out" pose frequent problems for your life or finances, I emphatically warn against making these sorts of systems. You may have designed an instrument with the goal of "being assembled", not the goal of making sounds you will definitely enjoy. Depending on your ardor for this sort of thing, it's likely that completing this system will be all you can think about in terms of synthesis. Other systems may cease to be refined or built upon as you try to realize this obscure concept above actually making music. Once it's complete, the single manufacturer which inspired this system may release new modules that change your plan. The hole in your wallet reopens. As stated above, these systems can be enlightening and a fun way to support makers which you deeply wish to support, but know what you are getting into before embarking on this sort of project: A goal of making a themed system, not necessarily making something *with* the system.

Don't Rack It - Continuing the theme of expanding your collection with caution, consider too that every single module does not need to be plugged in all the time. If something does not fit, it doesn't necessarily need to be resold. Have a safe place to keep your spare modules in their original boxes, and some sort of catalog to remember where they are and what they are. The modules which live "on the bench" can be swapped into your smaller systems or subsystems to fulfill their roles in a future design. These modules tend to be sold off to afford newer modules, especially in the hands of collectors seeking something new and exciting, but you truly never know when that mini mixer or wavefolder will be needed for a neat patch recipe or routing issue in your larger system.

"To Every Thing: Turn, Turn Turn" - The last thing to keep in mind, when you have a large collection of modules, is how knobs work. Generally, knobs can lubricate themselves over the module's lifetime simply by being turned. If knobs are left in dusty,

dry, or just idle environments for long periods of time, they become unable to effectively lubricate themselves as the oil inside the potentiometer's housing is too crusty to be distributed across the base of the cylinder. Stagnant, dusty, dried-out oil creates crunchy noises in the signals which pass through it when it's turned. It can also cause the knobs to become stiff and harder to twist which is particularly unpleasant to deal with on tiny knobs. While certain compounds and cleaners can temporarily alleviate this issue, nothing beats the resilience of the original treatment of lithium grease in a potentiometer's housing.

The best way to keep these knobs fresh is to turn them! As your collection expands, remember that it's a good idea to give every single knob a good turning several times at their full rotation range once or twice a year. Set a calendar reminder for your knob days, as it doesn't take as long as you think it will for your next knob day to arrive. I find the biggest pain in this process to be a literal one from vigorously turning knobs nonstop for several minutes, so I actually suggest involving your partner or beloved family members in this undertaking. Offering a good friend a drink of their choice for help also works. Their company can make this sometimes massive undertaking, when it comes to huge systems, more enjoyable and take much less time to complete!

A1 - Appendix 1: The First 5 Modular Lessons

The original intended audience for this guide was the journeyman and intermediate user. Someone who is familiar with the basics but lacks direction when it comes to building or arranging their system. To my surprise, v1.0 of this guide quickly became popular among newer synthesists who used it to understand modular methodology. Many of these readers were software-based synthesists exploring modular for free within sandbox-style modular synth software for the first time.

I think that's great, because there's two major hurdles to modular at the time of writing: Money and knowledge. Open source modular software bridges the gap on the former: Some particularly rare and complex modules can cost as much as a gaming computer which can run a full virtual rack on its own. Let this guide then bridge the latter. Everyone should be able to experience the joy of designing and playing an instrument, and the free-flowing world of routing control voltage allows us to interface with creating sounds on a meticulous level at a free-flowing pace.

To provide greater value to the newer synthesist who is trying to understand modular, I would like to proffer five important epiphanies which struck me as a new synthesist in the hopes that it can help others understand modular synthesis. This section is informed by my own experience, and the experiences of helping others learn modular hardware and software solutions. The following discoveries cover five strikingly common pitfalls with layman's explanations for greater understanding.

A quick note before we begin:
Experienced synthesists may read this section and correctly surmise "That's oversimplifying things." or "I can think of a handful of exceptions to this assertion." By the time you're challenging these paradigms, you probably don't need this section. Where it seems appropriate, I will note that these simple versions of synthesis knowledge belie a greater well of creativity. The things glossed over are concepts such as when hardware CV switches and T&H systems have directionally agnostic ports. The informed synthesist will see and enjoy this sort of complexity later on, but the function of this section is to simplify common applications to foster basic synth patch understanding. So let's get patching…

Discovery 1: CV Moves Knobs For You.

This simple concept is the essence of modular formats and is likely the first thing you may discover on your own. By playing around on a semi-modular, or any complete synthesizer with a pre-wired configuration, you'll find out in an audible way exactly what the Cutoff Frequency knob on a filter does. Wouldn't it be great if your hand, or mouse clicker in a software environment, was unfettered by the onus of moving this knob around while you play around with other knobs and buttons? Everything great about modular lies in slinging this automation, referred to in synthesis as "modulation" appropriately enough! Modular + automation = Modulation!

Modular formats possess two kinds of jacks to plug into: in ports, and out ports. A well-labeled filter will have a "CV In" somewhere on it. Generally, sending signals to the "CV In" on a filter will move the Cutoff Frequency knob for you. If the filter has more than one knob, it may have more than one CV In. Twist these knobs around to become familiar with their functions and how they affect your sound, then plug an LFO with some kind of visual feedback on it (such as a light that pulses up and down upon the LFO itself, or any LFO routed through an oscilloscope) into the "CV-In" for the knob you'd like it to twist for you. Move the most conspicuous filter cutoff knob all the way left/counterclockwise to let the LFO twist it all the way to right. Watch the visual feedback on the LFO to see how it relates to the sound coming out of the system.

If it sounds very subtle, or like the LFO isn't moving anything after being plugged into the Cutoff CV, your filter probably has more than one or two knobs. These extra knobs are generally smaller or off to the side and these are attenuators: Knobs which determine how much an incoming signal is going to twist its assigned, related knob for you. Some of these are unidirectional where far left is no signal and far right is all the signal, but some are bidirectional where far left on the attenuator knob means "Twist this knob counterclockwise when you get positive signals and vice versa." In either case for this experiment, make sure these attenuator knobs, unlike the frequency and harmonics knobs, are all the way to the right/clockwise at first then adjust them later to be more pleasing.

What we've accomplished with one new cable connection is probably a noxious sound to hear, but it's the core of modular synthesis: Discrete devices sending configurable signals to one another to move a lot of knobs at once. They don't literally move the knobs of course, as the actual physical position of these knobs can now be used to determine where the incoming control voltage starts twisting them from. So let's examine what kinds of signals there are to send…

Discovery 2: Types of CV Signals *(and why plugging an oscillator into an ADSR did not work how you expected.)*
After sending signals around a bit, I found that not all outputs were equal. I had no idea what most of them were doing and had no access to an oscilloscope. If you find yourself in this oddly specific situation: I found that the frequency modulation input on my oscillator was a great way to monitor CV, and how a knob is being moved by the signal going into it. With this Audible Oscilloscope I saw roughly five distinct kinds of signals going on:

Tones: Tones are audible signals. They're a constant, repeating pattern shaped like a zigzag, wiggle, or other waveshape that repeats itself with incredible speed so as to be audible and screaming forever until it is switched off. When you plug an oscillator's triangle out into your mixer you will hear a tone. Same with the square out or sine out. Each has a different sort of tone to it. Try out a few, run them through a filter, from this almost everything audible in subtractive synthesis is shaped. There's also a non-repeating version of pure random called "Noise" which sounds like TV static.

LFOs: LFOs are the same shapes as tones, a single, unceasing pattern but these are not fast enough to be heard by human hearing. Sudden voltage changes may "tick" from the sudden jump of maximum to minimum and back, but otherwise these are used for slowly, over time, modulating other inputs such as waveshape, filter frequency, and reverb length. If you speed these up enough, they become a tone!

Triggers (and Gates!): Triggers are a blip.Like a square LFO, you'll hear a blip coming from these as well for the swift voltage changes which go from a minimum to a maximum position. These are non-repeating without an event of some sort that causes them. Many keyboards send these fast up-and-down trigger signals out of their Trig output when you press a key, and the up-down is instantaneous. Drum sequencers may also send trigs to a beat or tempo. The purpose of these blips is to send activation signals to other modules. A gate is similar, but instead of it being a blip of a fixed length, it stays at a high voltage until it is released. This release of voltage going instantaneously back to zero can be executed at a configurable time, or coincide with a "Release" event like lifting a key on a keyboard.

Envelopes: These can be thought of as a "shaped trigger." When it receives an in-signal, ideally a trigger or gate, it begins playing its "envelope shape." These are more gradual changes, like an LFO, that do not repeat. They begin when they receive that in signal and end eventually, depending on a few more technical aspects of the envelope. If you plug a tone into the IN port of an envelope generator, it will trigger the envelope as fast as your tone is crossing a high-enough voltage to trigger the envelope.

This is activating the envelope at audio rate!

V/Oct: This is a special sort of modulation signal which corresponds to musical notes. Someone has done this math so you don't have to. A V/Oct signal to a V/Oct in port of an oscillator turned to C will receive accurate musical information from a sequencer sending V/Oct quantized information. If you're having trouble making musical tones with a tone, try sending it V/Oct info into its V/Oct port.

Discovery 3: Voltage is Voltage
Take a while to explore the 5 types of signals described above because they will help you conceptualize how synthesis works. Inaudible things turning knobs for audible things to be heard in different ways over time. Understand them all? Good, next lesson:

All those types are fake.

Rather, none of those have a predetermined and singular purpose. While understanding these common types of signals may help you make music with your modular, these rules can be broken by any device that adheres to the voltage requirements for your chosen modular format.

What I've described are common uses for those types of CV signals in modern subtractive synthesis. A good first patch. Just as I said "If you plug a tone into the IN port of an envelope generator, it will trigger the envelope as fast as your tone", you can generally use any of these CV types in any module's modulation inputs. If you do patch your envelope generator in such a way, if you keep the rise and fall periods short enough you can turn a square wave into a saw wave! A V/Oct in jack doesn't need quantized information, strictly speaking, you can send that anything as well: You can modulate the pitch of your oscillator with a manually triggered envelope to make raygun noises. You can modulate the pitch of this oscillator with the output of another, a "Tone acting upon a Tone" (though an attenuated "FM" input is generally better for fine-tuning this sort of patch)

Each type of CV can perform duties assigned to another type of CV and the effects are incredibly sonically interesting. Once you understand the basics, this is how you can start experimenting with more advanced and experimental concepts. While you're patching…

Discovery 4: Get an Oscilloscope (I mean it)
As you're experimenting with this new sonic frontier, you will definitely get lost. Not a fun kind of lost, but genuinely lost: Why does this behave like that? Why did plugging in

here mute the signal? What happens to my audible waveforms if I plug them into a delay?

The best way to answer these questions (which in reality have a ton of case-specific answers) is to run your signal through an oscilloscope and zoom in. It's an essential tool for learning. Some questions can be answered by plugging control voltage into an oscillator's pitch control, so you can hear just in general what the voltage is doing, but it doesn't answer the difficult questions. Unless you have a mentor to pester about literally everything you run into on your way to synth mastery, this Oscilloscope will be your little glowing friend that's helping you figure this all out. If you're working in a virtual environment, I suggest that my apprentices stick an oscilloscope after each module in a simple patch just to see what each kind of module does to a signal.

You may not always need one, strictly speaking, but you can sell or gift your oscilloscope to a new synthesist when you're done with it. Perhaps you'll get into designing your own modules and you will need an oscilloscope to troubleshoot your designs. They also just generally add a visual flair to your synth, so even though it doesn't make noise an oscilloscope is an investment in your future synthesis skills. Be sure to grab one, even a cheap one, so long as it's responsive at an audio rate.

Discovery 5: How to not literally, actually, completely blow up your modules.

It's shockingly easy to accidentally destroy your amazing new module by plugging it in wrong or not taking care of it.

At time of writing, modular is still very much in a "wild west" era where the protections we enjoy in other consumer-grade products are entirely missing from modular synthesis. A few pitfalls lead to countless shame-filled sales on modular marketplaces which say "Non-functioning, plugged in backwards, maybe someone can fix it." So to reduce the risk of this happening to you, here's some quick tips on how to keep your screaming rectangles in operating order:

> *Ask the manufacturer or manual how to plug in the power for a module:* When you look at the cable and plug of a eurorack module for instance, it looks obvious how to plug it in. There is no warning whatsoever that there's a 50/50 chance you're "blow up the module" wrong if you just plug it in with only "this looks right" as your guide. Many formats simply allow you to get it wrong, so it's possible to reverse the power cables on formats such as Eurorack and fry your whole case. Look it up or blow it up, and pay close attention to all pinned connections that you are not plugging anything in off-center or backwards as cable orientation and rotation means pass or permanent failure for

these connections.

Take it from someone who literally toasted an $80 USD antique IC on a hot-swappable component slot from plugging it in backwards after doing this stuff for 5 years: Always double check powered connections before turning your case back on to test. Many experienced modular folks have a similar story - not about if they toasted a module but when they broke something on accident and it's generally far into their modular hobbyist careers. No amount of experience will make you perfect at this every time so be alert and stay alert in regards to power. Remember: Every module is different, and only trust the manufacturer's advice if the markings on the power connection's circuit board are missing or not clear enough.

> **Don't use stackable cables to add signals together:** Many formats allow for "stackable cables." These are cables with jacks on the top for plugging another cable into. This way you can mult things like a clock signal to more than one source. Convenient! However it's also possible to use these to break your device.

Most formats have a definite voltage peak, so let's say… 5V. If you send a single input an envelope that hits 5V at its peak AND an LFO with a 5V peak you can very easily send more than 5V into a jack. This overload could blow a resistor or worse. Stackables are for multing signals coming **out** of a module to send it to multiple destinations, not for combining things going in.

Luckily, many formats have "adder" and "precision adder" modules. "Precision adders" are needed for pitch information on an analog device whereas non-precision adders can handle anything else just fine, musical pitch is just that finicky. Adding an attenuated LFO to an envelope is a nice way to make a wavy envelope, so don't let the need for an adder dissuade you from adding signals properly. An adder will safely cap the voltage on any two or more signals you throw at it for adding, and it's a great tool for getting creative with CV.

> "**Dustin' makes me feel good~:**" Modules hate dust! The construction of most potentiometers (or "knobs") is such that an arm under the surface will push away small amounts of dust. Letting it accumulate over a long period of time overwhelms this fair-weather measure against dirt. Excess dust leads to scratchy knobs that need total replacement or short-term repair while you look into how to replace them (because potentiometer lube can extend the life of a scratchy pot, but it doesn't fix the part that's already been scratched to heck by dust!)

Two practices help you keep your modular all in working order and just these two

practices have worked wonders for me. My very first module, which I use in almost every patch, is still in perfect working order because I dust frequently, and do annual "knob turning days" around Halloween.

Dusting is easiest, I find, if you get a middling-quality large paintbrush and use those long bristles to briskly sweep between the knobs, levers and buttons. It's quick, easy, and should be done whenever the dust on your modules starts to become visible from a casual distance. Once or twice a month under most circumstances should be fine, just keep that brush by your modular so it's a quick and casual bit of maintenance to do.

"Knob Turning Day" is celebrated by many synthesists at different times all around the globe and at different times of the year. On this day you turn every knob on your system. A lot. Turn every single knob, fader, switch and analog actuator all the way to the bottom value, then all the way to the top. Do this 10 to 20 times to help clear dust off the potentiometers underneath the knobs that control them. After a few dozen knobs you'll start getting a feel for what kind of tactile gritty feeling you're working out of your ill-used parts. For my own studio this process can take several hours! For a beginner's system, this shouldn't take much longer than 5 or 10 minutes. Let this needed bit of maintenance inspire you to not fill a whole room with more synths, so that knob turning day remains a strange little ritual and not something you need to schedule with friends and loved ones to come help you out.

F - Outro: Switching Paths and New Solutions

By the end of this guide, you may feel that more than one of these synthesist archetypes describes you. This is common. When conducting informal interviews for research into this guide, and the paradigm that supports it, I found that most synthesists have more than one goal for their modular synthesizer. There are Explorer/Musicians, Fancier/Collectors, Collector/Musician/Explorers, really every cartesian product of the five types could apply. You could move from one type to another, as I've known many Explorers who transition into Musicians. When you have several types, or are moving from one path to another, the structure of your instrument should change to match… but how do you apply that?

For now, as best as you can. Assembling one instrument for each synthesis type helped me write this very guide, so that is one option. Another is to read the chapters for both types, and try to apply some or all of the information therein to a single design. I've also had two competing interests waxing and waning against each other like Conway's game of life upon a single, small instrument. Perhaps the modular community, which this guide is dedicated to, will find more solutions to the question: "How do I design a synthesizer as an extension of my most creative self?"

Thank you for reading this guide. I hope it inspires you to create your instrument, and enables you to easily find it.

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You can find my many synthesizer jams and experiments here
https://www.youtube.com/@motherdessicant

If you like dark ambient or just need a soundtrack for your spooky D&D campaign:
https://motherdessicant.bandcamp.com/

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Donations are nice but all I ask is if this guide helped you, please share it with another person. Perhaps it will help them as well! If it proves popular, It's my goal to release this guide in an illustrated, full-color, physical form someday soon.

Version History
1.0.0 - Initial Release
1.0.1 - Added cover image/ToC Links, fixed font sizes and header pagination.
1.1.0 - Added 5 First Lessons. Several more grammar and spelling fixes!

Keep information free!

Happy beeping!
-Vera/Mother Dessicant