# *Introduction to synthesis - Part 1*

@ Intro to Synthesis Part 1 - the building blocks of sound & synthesis
Dean Friedman

Published on YouTube Jan 4 2012

www.youtube.com/watch?v=atvtBE6t48M

05:12 Basic Terminology

08:00 3 Elements of Sound
08:20 Pitch
10:01 Timbre
10:45 Harmonics
14:57 *
16:40 Filter Cutoff/Timbre
18:08 Volume

21:53 5 most common Waveforms
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24:59 Pulse Wave
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28:48 *Waveforms as Modulators

30:47 7 Components of Synth
32:11 Amplifier
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34:18 Filter
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40:42 *Corresponding Components*
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Notes 2017-12-08

## *Introduction to synthesis - Part 1*

1. Sound - all sound is vibration

2. 3 Elements of sound:

   Pitch
   Timbre
   Volume

3. 5 most common waveforms:

   Square
   Sawtooth
   Triangle
   Pulse
   Sine

4. 7 main components of a synthesizer:

   Oscillator
   Amplifier
   Filter
   Volume Envelope
   Filter Envelope
   Pitch Envelope
   LFO

VIBRATIONS

Synth: controlling vibrations

Cycle = unit of vibration
Frequency = speed of vibration
HERTZ = cycles per second
KILOHERTZ = 1,000 Hertz

Human audible frequency range: 20Hz - 20KHz

THREE ELEMENTS of SOUND

## *Introduction to synthesis - Part 1*

PITCH: musical term for frequency
(Synth oscillator controls pitch)

TIMBRE: unique character, tone of a sound
harmonic structure

HARMONICS:
most sounds are composite sounds
fundamental + harmonics (overtones, partials)
sound harmonic spectrum

pitched instruments vs. non-pitched instruments (e.g., saxophone vs. drums)

e.g., bell: short attack, long release
dissonant harmonics
Filters are how to add and subtract harmonics
Upper harmonics - brighter
Lower harmonics - darker

VOLUME: overall sound shape
different sounds have different shapes
volume envelope

FIVE MOST COMMON WAVEFORMS

SQUAREWAVE: instant on, instant off

SAWTOOTH: instant on, gradual off

TRIANGLE: gradual on, instant off

PULSE: instant on, instant off (Squarewave with a variable ratio)

SINE: single pure frequency

Modulation: applying one waveform to another

SEVEN MAIN COMPONENTS OF A SYNTHESIZER

AMPLIFIER (controls volume)

OSCILLATOR (OSC, VCO) (controls pitch)

FILTER (VCF, DCF) (controls harmonic content - timbre)

VOLUME ENVELOPE (instructions about rates and levels over time)
Attack, Decay, Sustain, Release

FILTER ENVELOPE (shape for brightness; harmonic envelope)

PITCH ENVELOPE (shape for pitch)

LFO (Low Frequency Oscillator) (make things wiggle)
- lower than audible range
- used as a modulator

- frequency modulation - vibrato
- amplitude modulation - tremolo
- filter modulation
- pulse modulation

DEMO

Choose waveform in oscillator

Designed a volume env - shape for sound
Designed a filter env - brightness shape
LFO - using a triangle wave as a modulator on the pulse wave

# *Introduction to Synthesis - Part 2*

@ Intro to synthesis part 2 - types of synthesis & programming
Dean Friedman

Published Jan 4, 2012

www.youtube.com/watch?v=gJkxGvhOS-M



DIFFERENT KINDS OF SYNTHS

all have volume envelope
all have a way to change the shape of a sound
all have LFO

ANALOG - prior to computer tech
raw current vibrating oscillator directly to speaker

DIGITAL
sound generated via software or microprocessor

## *Introduction to Synthesis - Part 2*

A or D: How is the sound originally generated?

ADDITIVE / SUBTRACTIVE

Additive synth: add individual sine ways to create a harmonic spectrum
very precise - need a separate oscillator for each note

Subtractive synth: generate a single waveform rich in harmonics
then filter - subtract harmonics

FM Frequency Modulation
modulate frequency of one sine wave with the frequency of another sine wave
yields a complex waveform rich in harmonics

Phase Distortion - related to FM

SAMPLERS: make digital recordings of real sounds
play back from a keyboard
all have volume envelope & LFO (& filter)

HYBRIDS
use complex digital stored wavetables (samples) as source material (other than simple waveforms)
Linear Algorithmic (LA) synthesis

7 COMPONENTS of a SYNTH

Amplifier - loudness
Oscillator - pitch
Filter - brightness / timbre
Volume Envelope - w/ the amplifier modifies shape of sound over time
Filter Envelope - w/ the filter modifies shape of sound harmonic content over time
Pitch Envelope - w/ the oscillator modified shape of sound pitch over time
LFO - wiggles the sound (vibrato or tremolo)

AMPLIFIER

controls loudness / volume / level

control relative levels between different oscillators

OSCILLATOR
VCO, DCO, OSC, Frequency
controls frequency or pitch

width of pulse wave (also called duty cycle)

Octave / Semitones / Fine tuning

D50 Master (Soundquest) Voice editing software
- edit voice architecture (structure?)

chorusing / de-tuning: create more distinctive sound

intelligent choices made on source material prior to any other modifications

FILTER (VCF)
controls harmonic content of a sound; overall brightness

CUTOFF control: cut-off point (frequency) at which the filter cuts off harmonics (closed - dull; open - bright)
RESONANCE: exaggerate harmonic frequencies around cutoff point
ENVELOPE AMOUNT: degree to which filter envelope affects the sound (cutoff point of the filter)
(Envelope Generator (EG) intensity; Envelope amount / depth / intensity)

Filters controls by removing or replacing the upper portions of harmonic spectrum (SUBTRACTIVE)

MODULATOR [FM Synths]
Controls the harmonic content of the sound; the timbre of the sound

ADDITIVE: changes harmonics by adding harmonics to a sound

Frequency Modulation (FM): one waveform modulates another waveform => complex waveform
(like multiplication)

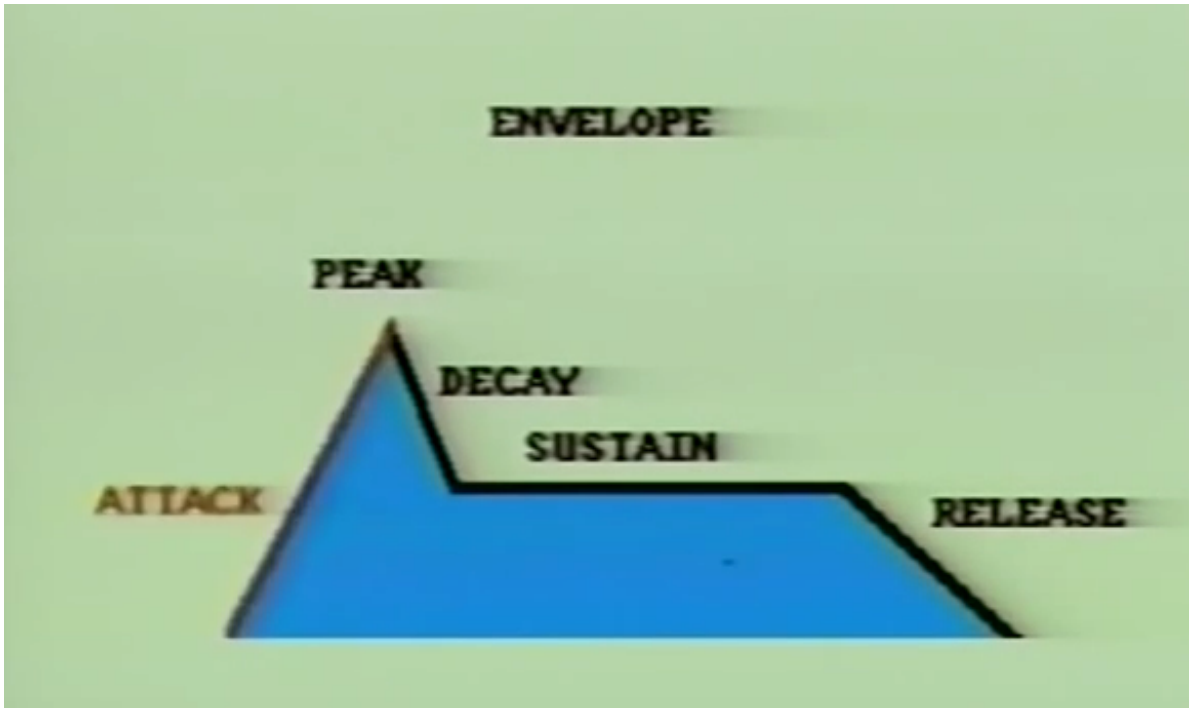
VOLUME ENVELOPE

ADSR - Attack Decay Sustain Release
(Peak - max volume; located between Attack and Decay)

Increase attack: sound begins gradually
Decrease attack: sound begins suddenly

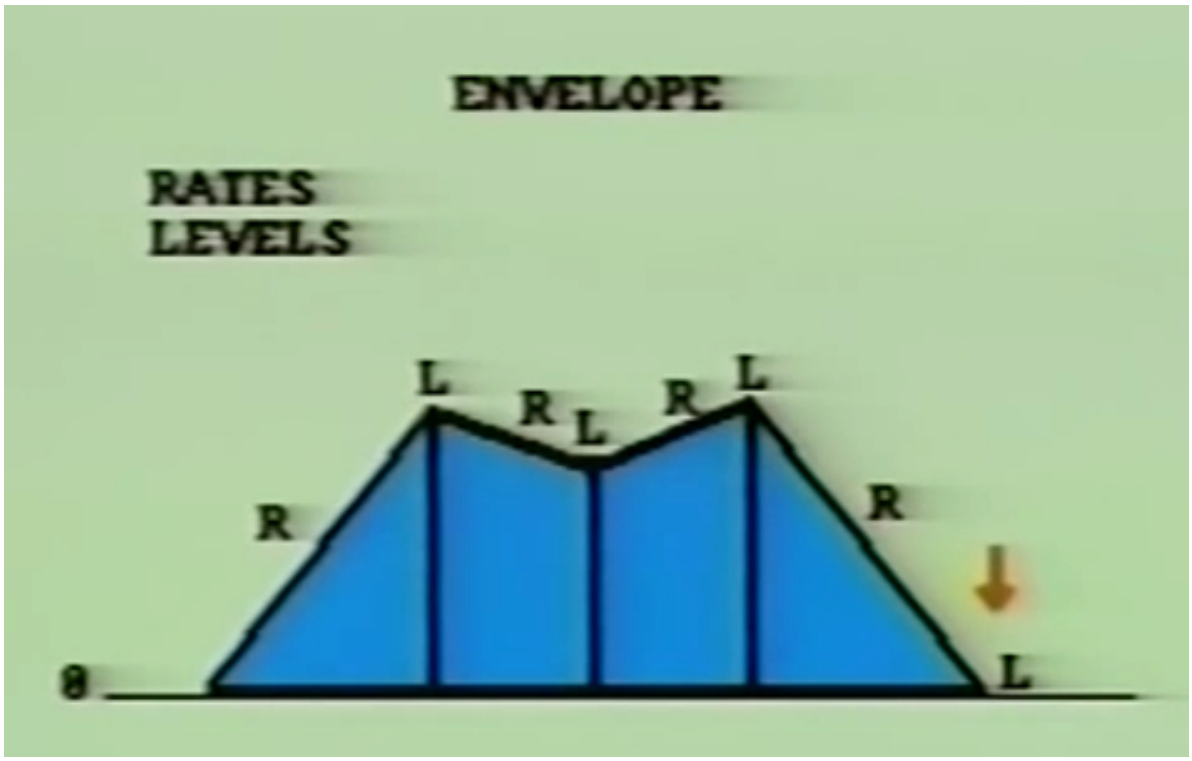
Attack: rate control; speed sound takes from 0 level to peak level (cannot be adjusted)
Decay: rate control: speed sound level travels from peak to sustain
Sustain: volume level the sound will remain at while key is held down (only variable level)
Release: rate control: speed sound takes to travel from sustain to 0 level

ENVELOPE shape




ENVELOPE.png

ENVELOPE Rates and Levels




ENVELOPE-ratesLevels.png

FILTER ENVELOPE
(Harmonic Envelope)
ADSR Controls the shape of a sound's brightness (timbre) over time

Filter Envelope is superimposed over the Volume Envelope

PITCH ENVELOPE
Controls direction of the sound's pitch
(usually easy to hear pitch level changes and rates)
Slide up, down, up & down

LFO: LOW FREQUENCY OSCILLATOR
"wiggles" the sound (modulates)

sends a continuously repeating vibration to some aspect of the sound (the volume, timbre, or pitch)

Control Level (amount / intensity)
Frequency (rate/speed)
Waveform (triangle, sawtooth, square, sine, noise(random))

route LFO to modulate the amplifier - amplitude modulation - "tremolo"

route LFO to modulate the oscillator - frequency modulation - "vibrato"

route LFO to modulate the filter - filter modulation

possible to route LFO to modulate the width of the Pulse Wave

LFO SYNC: Off/On

@ Intro to Synthesis Part 3 - Additional Synth Features, Performance Controls, & Wrap Up
DEAN FRIEDMAN

https://www.youtube.com/watch?v=zK3m8sMkTE4

Published Jan 4, 2012

02:28 Noise
04:44 Sync
08:00 Amplitude (Cross) Modulation
Performance Controls / Controllers
11:25 Pitch Bend wheel
13:28 Modulation Wheel
16:20 Velocity Sensitivity
21:22 24:13 Aftertouch
26:53 28:24 Keyboard Tracking [key tracking / scaling / follow]
29:15 DEMO #1
32:18 * 32:57 34:24 DEMO #2 Attack Vol Env/Frequency LFO
34:45 39:13 DEMO #3 Rate & Sustain Vol Env/Frequency LFO
40:00 48:01 DEMO #4 Filter Env/Vol Env/LFO
48:55 DEMO #5
50:30 54:11 DEMO #6 LFO/Detune
55:27 DEMO #7

**Synths used in demos**
Roland D50
Casio CZ
Roland DX7
Korg M1
Ensonic SQ80

NOISE

SYNC

## *Mod Synth Basics #04*

@ Modular Synth Basics #04: Simple synth voice patch
Published 2 Mar 2014
https://youtu.be/lJ0M9b4mRNc

Our first patch! A simple synth voice, like in a non-modular synthesizer. EXPAND FOR MORE INFOS and subscribe for more videos: http://www.youtube.com/subscription_c...

PATCH NOTES:

VCO = Voltage Controlled Oscillator (creates audible waves)
VCF = Voltage Controlled Filter (removes frequencies from audio)
VCA = Voltage Controlled Amplifier (controls a signals volume/amplitude)
ADSR = Attack Decay Sustain Release Envelope Generator (creates a 4-stage CV envelope when triggered)
LFO = Low Frequency Oscillator (creates very slow inaudible waves, used as CV)

Audio Signal Routing:
VCO waveform output -to- VCF audio input
VCF Low Pass output -to- VCA audio input
VCA audio output -to- Mixer input
Mixer output -to- Audio Recorder input

Control Voltage (CV) Signal Routing:
MIDI-CV Gate output -to- ADSR Gate input
ADSR Envelope output -to- VCA CV input
MIDI-CV Pitch CV output -to- VCO 1V/Oct input
LFO output -to- VCF Frequency CV input

==========

VCO > Mixer
VCO > VCF > Mixer
VCO > VCF > VCA > Mixer

MIDI-CV Gate > VCA | MIDI-CV PitchCV > VCO

## *Mod Synth Basics #04*

MIDI-CV Gate > ADSR > VCA | MIDI-CV PitchCV > VCO
MIDI-CV Gate > ADSR > VCA | MIDI-CV PitchCV > VCO | LFO > VCF

Modular Synth Basics #02: CV, Gate, Trigger, MIDI
https://youtu.be/7TcHzHhjzs8

Terminology

- Gate = high voltage over time

- Trigger = short voltage spike

- Pitch CV = variable CV to control 1V/Octave Oscillators

Modular Synth Basics #03: How to start?
https://youtu.be/Q0ltu37toDc

Software synth: Modular for iPad

modulargrid.net
muffwiggler.com

Modular Synth Basics #08: Multiples

- Multiples create copies of a signal
- Passive multiples do not need electricity
- Buffered multiples need electricity and copy precisely (no voltage loss)
- Have enough multiples available (1 2x4 multiples per row)

Modular Synth Basics #09: Linear & Exponential
https://youtu.be/QXS1v2CQLOY

Exponential modules for audio processing (human sense experience)
Linear modules for CV processing (want CV mods to be linear)

- The human ear perceives volume increases logarithmically
- To be perceived linear (smooth changes), need to increase exponentially
- CV operations usually stay linear

@ Modular Synth Basics #10: Clocks & Sequencers
https://youtu.be/Zoeo8mK_zsE

## *Mod Synth Basics #04*

Clock divider modules
Sequencers

- Clock CV signals are repeating Gates or Triggers
- Clock CV can be generated from LFOs, Clock Modules, Expert Sleepers, etc.
- Clock Divider creates synced slower clocks from incoming clock CV signal
- Gate / Trigger Sequencers output pulses at fixed voltage levels (drum rhythm)
- CV Sequencers output continous variable voltage levels (melody)
- Reset inputs start sequencers from the beginning

Modular Synth Basics #11: Self-playing synth voice patch (with Sample & Hold)

Previous patch:
VCO > VCF > VCA > Mixer
MIDI-CV Gate > ADSR > VCA | MIDI-CV PitchCV > VCO | LFO > VCF

This patch:
LFO > ADSR > VCA | MIDI-CV PitchCV > VCO | LFO > VCF

Add Sample & Hold
LFO > ADSR > VCA | Noise > S&H > VCO | LFO > VCF

Use a Multiplier

LFO > Mult > ADSR > VCA | Noise > S&H > Attenuator > VCO | LFO > VCF
    ----------> Clock Div >

@ Modular Synth Basics #12: Envelopes & Function Generators
https://youtu.be/SBTiaGG6T6A

- Function generators create CV signals that change over time
- Also called envelope generators (EG)
- Have to be triggered to create CV
- Many are based around ADSR concept

Modular Synth Basics #15: The cheap way into Eurorack (modular synths on a budget)
https://youtu.be/xvu1ZCR5Iy8

Get:
- a semi-modular synth
  Arturia Microbrute

## *Mod Synth Basics #04*

Doepfer Dark Energy

- a Eurorack case
  6 U Eurorack case with power (Doepfer DIY case)

- 1 or 2 Eurorack modules
  VCO
  LFO (cannot have too many)
  EFFECTS: VC delay, VC bitcrusher, VC Fuzz

@ Modular Synth Basics #16: Waveforms on an oscilloscope
https://youtu.be/0nuxXM9QQPA