The Microphone: Chapter 4 Lesson 4

Microphone - (mic) is usually the first device in a recording chain. Essentially, a mic is a transducer that changes one form of energy (sound waves) into another corresponding form of energy (electrical signals)

THE "GOOD RULE"

Good musican + Good Instrument + Good Performance + Good Acoustics + Good Mic + Good Placement = GOOD SOUND
M.I.P.A.M.P.

Rule 1: There are no rules, only guidelines
Rule 2: The overall sound of an audio signal is no better than the weakest link in the signal path.
Rule 3: Whenever possible use the "Good Rule" M.I.P.A.M.P.

Microphone Design
- Dynamic
- Ribbon
- Condenser

Theory of Electromagnetic Induction
Whenever an electrically conductive metal cuts across the flux lines of a magnetic field, a current of a specific magnitude and direction will be generated within that metal.

Dynamic Mic - in principal it operate by using electromagnetic induction to generate an output signal. They generally consist of a stiff Mylar diaphragm of roughly .35-mil thickness. Attached to the diaphragm is a finely wrapped core of wire (voice coil) that's precisely suspended within a high-level magnetic field. Whenever an acoustic pressure wave hits the diaphragm's face (A), the attached voice coil (B) is displaced in proportion to the amplitude + frequency of the wave, causing the coil to cut across the lines of magnetic flux that's supplied

by a permanent magnet (C). In doing so, an analogous electrical signal (of a specific magnitude and direction) is induced into the coil and across the output leads, thus producing an analog audio output signal.

Ribbon Microphone - the ribbon mic also works on the principle of electromagnetic induction. Sound pressure variations between the front and the back of the diaphragm cause it to move and cut across these flux lines, inducing a current into the ribbon that's proportional to the amplitude and frequency of the acoustic waveform. Because the ribbon generates a small output signal (when compared to the larger output that's generated by the multiple wire turns of a moving coil), its output signal is too low to drive a microphone input stage directly; thus, a set-up transformer must be used to boost the output signal and impedence to an acceptable range.

Condenser Microphone - operate on an electrostatic principle rather than the electromagnetic principle used by dynamic or ribbon. The capsule of a basic condenser mic consist of two plates: One very thin moveable diaphragm and one fixed back-plate. These two plates form a capacitor. A capacitor is an electrical device that's capable of storing an electrical charge. When sound acts upon a movable diaphrgm, the varying distance between the plates will likewise create a change in the device's capacitance. These mic will need external power source, battery or phantom power.

phantom power - it works by supplying a positive DC supply voltage of +48V through both audio conductors (pins 2+3) of a balanced mic line to the condenser capsule and preamp. This voltage is equally distributed through identical value resistors, so that no differential [redacted] exsist between the two leads.

Electret-condenser Microphone - it works on the same operating principles as their externally polarized counterparts, with the exception that a static polarizing charge has been permanetly set up between the mic's diaphram and it's backplate

Microphone Characteristics

Directional response - of a mic refers to its sensitivity (output level) at various angles of incidence with respect to the front (on axis) of the microphone

Polar Pattern - the angular response can be graphicly charted in a way that shows a microphone's sensitivity with respect to direction and freq over 360°.
- Omnidirectional
- Directional

Omnidirectional mic - is a pressure operated device that's responsive to sounds that emanate from all directions

Bi-directional - (figure 8 pattern) pick ups are responsive to relative differences in pressure between the front, back and sides of a diaphram.

Directional - Polar Pattern - Cardiod, supercardiod + hypercardiod

Frequency response (on axis) curve of a microphone is the measurement of its output over the audible freq range when driven by a constant, on-axis input signal.

At low freq, Rumble (High-level vibrations that occur in the 3-25 Hz region) can be easily introduced into the surface of a large unsupported floor space, studio or hall from any number of sources (such as passing trucks, air conditioner, subways or fans). They can be reduced or eliminated in a number of ways.

- Using a shock mount to isolate the mic from the vibrating surface and floor stand.
- Choosing a mic that displays a restricted low-freq response
- Restricting the response of a wide-range mic by using a low freq roll-off filter.

Proximity - a low-freq phenomenon that occurs in most directional mics this effect causes an increase in bass response whenever a directional mic is brought within 1 foot of the sound source.

Transient Response - is the measure of how quickly a mic's diaphram will react when it is hit by an acoustic wavefront

Output Characteristics - refer to its measured sensitivity, equivalent noise, overload characteristics, impedence and other output response.

Sensitivity Rating - is the output level (V) that a mic will produce, given a specific and standardized acoustical signal at its input (in dBSPL)

Equivalent Noise Rating - of a mic can be veiwed as the device's electrical self-noise. It's expressed in dB SPL or dBA (a weighted curve) as a signal that would be equivalent to the mic's self-noise voltage.

Overload Characteristics - just as a mic is limited at low levels by its inherent self-noise, it's also limited at high sound-pressure levels (SPLs). In terms of distortion, the dynamic mic is an extremely rugged pickup, often capable of an overall dynamic range of 140dB

Microphone Impedance - output impedance is a rating that's used to help you match the output resistance of one device to the rated input resistance requirements of another device (as to provide the best-possible level and freq response matching)
Impedance is measured in Ohms (Ω or Z)

Balanced and Unbalanced lines - a balanced line use 3 wires to properly carry the audio signal. Two of the wires are used to carry the signal voltage, while a third lead is used as a neutral ground wire.
An Unbalanced circuit, a single lead carries a positive current potential to a device, while the second, grounded shield (which is tied to the chassis ground) is used to complete the circuit's return path. High-impedance mics and most line-level instrument lines used unbalanced circuit.

Pickup characteristics as a function of working distance

- Distant miking
- Close "
- Accent "
- Ambient

Distant miking is often used to pickup large instrumental ensembles (such as a symphony orchestra or choral ensembles.

Close miking is often used positioning about 1" to 3' from the sound source

Accent miking is used, care should be exercised in placement and pickup choices. The amount of accent signal that's introduced into the mix should sound natural relative to the overall pickup, and a good accent mic should only add presence to a solo passage and not stick out as separate, identifiable pickup

Ambient miking places the pickup at such a distance that the reverberant or room sound is equally or more prominant than the direct signal. Aplications - Live concert hall, +/or audience, studio - space + natural

Boundry Mic - places an electret-condenser or condenser diaphram well within these low height restrictions. For this reason, this mic type might be a good choice for used as an overall distant pickup, when mics need to be out of sight (when placed on a floor, wall, or large boundry)

Stereo miking techniques - refers to the use of two mics in order to obtain a coherent stereo image

- Spaced Pair
- X/Y
- M/S
- Decca tree

Direct Injection (DI)- serves to interface an instrument with an analog output signal to a console or recorder in following ways.

- It reduces an instrument's line-level output to mic level for direct insertion into the console's mic input jack.
- It changes an instrument's unbalanced, high source impedance line to a Balanced, low source impedance signal that's needed by the console's input stage.
- It often can electrically isolate the audio signal paths between the instrument and mic/line preamp stages (thereby reducing the potential for ground loop hum and buzzes).

Reamping it in the mix - a way to alter the sound of a recorded track or inject a new sense of acoustic space into an exsisting take. Ex: reamp process lets us record a guitars signal directly to a track using a direct box during the recording session and then play this cleanly recorded track back through a miked guitar amp/speaker, allowing it to be rerecorded to new tracks at another time.

Brass

Trumpet - E3 to D6 (165 - 1175 Hz) - off the bell's center - 1' or more closer app -10-20dB pad, and/or windscreen
Trumbone - E2 to C5 (82 - 523 Hz) - off the bell's axis - Jazz 2" to 12"
Tuba - B (31 Hz) - at least 2' slightly off-axis from bell
French Horn - B1 to B5 (62 - 700 Hz) - omni or bi directional mic between the rear, reflecting wall and the instrument's bell

Guitar

Acoustic guitar - balance off axis or X/Y pair - 6" - 1'
Electric guitar - E2 to D6 (82 - 1174 Hz) - cardiod dynamic - 2" - 1' from AMP less than 4" placement is critical + Direct box
Electric Bass guitar - E1 to F4 (41.2 - 343.2 Hz) - direct box, amp

Keyboard

GRAND piano - minimum 4'-6'

- Strings and Soundboard, often yeilding a bright and relatively natural tone
- Hammers, generally yeilding a sharp, percussive tone
- Soundboard Holes alone, often yeilding a sharp, full bodied sound.

Position 1: attached to a partially or entirely open lid with boundry mic
Position 2: two mic positioned in stereo 1"-6", one over High string, one over low
Position 3: single mic or coincident pair just inside the lid, partial or entirely open between the soundboard + lid
Position 4: single mic or stereo coincident pair placed outside the piano facing the opening (appropriate for solo + accent miking)
Position 5: spaced stereo pair placed outside pointing into the piano
Position 6: single mic or coincident pair just over the hammers 4"-8" for pop or rock sound.

Separation can be acchieved, piano in isoroom, with gobos, mics inside the lid closed with blanket covering, overdub at later time

Upright Piano

Miking over the top - two mics, over low end, one over High end
Kick board - remove panel - two stereo - bass + High - about 8"
Upper sound board - reduce hammer attack, two mics - bass + High - facing the room away from walls

Electronic Keyboard

Miced either direct line-level input, or direct box

Percussion

- Normally micing consist of - kick, snare, high toms, low toms, high hat and variety of symbols
- MUST BE TUNED before each session
- If tuning doesn't get rid of the noises and rings - tape maybe used to dampen - cloth, dampening rings, paper towels, or wallet
- Barebone miking - snare, kick, two overhead - spaced pair or coincident

A mic's freq response, polar response, proximity effect and transient response should be taken in the account when matching to the various drum groups. Dynamic Range also important.

- Drums can be placed in an iso room
- to achieve bigger sound, larger open room while other instrument are in the other iso rooms
- reduce leakage in the studio - 4' or higher gobos

Kick - large diaphram made for kick
Snare - aimed just inside top rim 1" and/or another under neth (out of phase)
Overheads - spaced pair, X/Y coincident
Rack toms - 1"-2" from the outer rim (live sound 3"-6") / remove bottom place mic 1"-6" inside away from the top head
Floor toms - 2"-3" - same as Rack and inside same as rack toms
High Hat - above to pick up nuances of sharp stick attacks, on side slightly above or below the closing point, one mic can be used to capture high hat + snare by placing in the middle between whit a figure 8

Tuned Percussion Instruments

Congas + Hand Drums - 1"-3" above head - 2" from rim (Live - 1') can use one or X/Y (1' above). Low end drums can be miced 1'-3' from head, also 2'-6" at bottom (out of phase if top and bottom are miced)

Xylophone, Vibraphone + Marimba - two high-quality condenser or extended range dynamic pickups above (3:1 rule) A coincident pair can help eliminate possible phase errors, spaced pair will often yeild a wider stereo image.

Stringed Intruments

Violin + Viola - G3 to E6 (196 - 1300 Hz) - 45° from instruments face (solo - 3'-8' slightly over ad in front) (STUDIO 2'-3') (Fiddle or Jazz/Rock 6" or less) (live - electric pickup)

Cello - C2 to C5 (56-520 Hz) - flat respose mic placement 6"-3'

Double Bass - E1 to C (41 - 260 Hz) - mic placement f holes 6"-1½'

Voice

male bass voice - E2 to D4 (82 - 294 Hz)

upper soprano - up to 1050 Hz with harmonics up to 12 kHz

TRAPS recording human voice -

Excessive dynamic range - controled by mic technique (more away) or insert a compresser into the signal path. ~~[redacted]~~

Sibilance - occurs with the f, s + sh or overly accentuated, can be controled by inserting a freq-selective compresser (deesser) with moderate eqing.

Excessive bass boost due to proximity effect - often occurs with directional mics at close range, reduced if increase distance, also using omnidirectional, or through EQing

Mic tools for the voice

Popping with P and B sounds

- pop filter over the mic
- windscreen inbetween
- Taping pencil in front of mic to break up air blast
- Using omni-mic (less sensitive to popping, but might have leakage)

Reducing leakage and inadequate isolation

- choosing a tighter cardiod or hypercardiod pattern
- Isolating with gobos
- Iso-booth
- Overdubing later (Keep in mind carefully isolated "scratch" vocals can help glue the band together and give the vocalist a better feel for the song)

Woodwind Instruments

Flute, Clarinet, Oboe, Saxophone + bassoon

Clarinet - B clarinet - lower limit of D3 (147 Hz) + A clarinet lower limit of C3 (139 Hz) Highest is around G6 (1570 Hz) - mic should be aimed at lower finger holes @ 6" - 1'

Flute - B3 to C7 (247 - 2093 Hz) - classical - on-axis + slightly above 3' - 8' modern - 6" - 2' - both should be positioned 1/3 - 1/2 from the mouthpiece to the footpiece. To close to mouthpiece could pick up breathing

Saxophone - B-flat tenor sax (B2 to F5 [117 - 725 Hz])
E-flat alto (C3 to G5 [140 - 784 Hz])
STANDARD MICING - mic pointed toward the top of the bell, or clip-on mic

Harmonica - two types: DIATONIC + CHROMATIC
(Shure 520DX "GREEN BULLET" is a preferred mic)

Microphone Selection

Shure SM57:	moving coil dynamic cardiod 40 – 15,000 Hz Noise rating – 7.75 dB	vocals, snare, toms, kick, electric guitar + keyboard
AKG D112:	moving coil dynamic cardiod 30 – 17,000 Hz Sensitivity – 54 dB ± 3 dB	kick, bass guitar cabinets, other low-freq, high-output sources
Beyerdynamic M160:	Ribbon dynamic Hypercardiod 40 – 18,000 Hz Sensi – 52 dB Noise rate – – 145 dB output imped – 200Ω	handling High SPL without damage if hypercardiod respose yeilds a wide-freq response / low-feedback for studio + stage.
Royer Labs R-121:	electrodynamic pressure gradiat. figure 8 Generating elemnt – 2.5 micron – ALUMINUM 30 – 15,000 Hz ± 3dB Sensi – – 54 dBV output imped – 300Ω@1K (200Ω optional) max SPL: > 135 dB	flat + well balanced low end is deep + full mids are well defined + realistic high end is sweet + natural
Neumann KM180 Series:	Condenser Cardiod (183) + (184) hypercardiod (185) Sensi – 12/15/10 mV/Pa 20 – 20 KHz output imped – 60Ω Noise – 16/16/18 dB – A	KM183 – omni, compact mini mics

AKG C3000B: condenser
cardiod
20 - 20kHz
sensi - 25 mV/Pa (-32dB v)

low cost, large diaphram, bass roll-off switch, a -10dB pad + highly effective interal windscreen

MXL V67i: selectable capsule condenser
30 - 20kHz
Cardiod
sensi - 15 mV/Pa
imped - 200W
signal to noise ratio - 74dB
noise lvl - 20dB
max SPL for .5% THD: 140dB

two selectable diaphram, front = warm, back = brighter more airy, Red L.E.D. shines indicating the capsule is energized

Telefunken M216 stereo mic:
selectable pattern stereo condenser
20 - 20kHz
Cardiod, omni, 8, + 6 inbetween
sensi - 14mV/Pa
imped - 200 W
S-N ratio - 125dB
Noise lvl - 20 dB
Power req - Ela M916 with quadraphonic outputs

matched pair of 1" dual-sided capsules a new, oldstock NOS ECC81 vac tube matched custom wound transformers, custom power supply w/ stereo matrix + 240 encoding/decoding settings. Each channel offers 9 diff polar patterns providing an exstinsive range of stereo imaging possibilites