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"ALL IS GEOMETRY", SAID PLATO. AND IT IS FAIR TO SAY THAT HE PROBABLY DID NOT KNOW MUCH ABOUT THE REPRODUCTION OF SOUND WHEN HE MADE THAT STATEMENT. THROUGHOUT THESE DISCUSSIONS I HAVE USED THE WORD "GEOMETRY" WITHOUT REALLY TYING IT DOWN. IF WE WERE WRITING AN AUDIO TEXTBOOK WE WOULD DUTIFULLY INTRODUCE OUR TERMINOLOGY, DEFINE IT, AND EXPLAIN WHAT IT MEANT. THEN TOWARD THE END OF THE BOOK WE MIGHT DISCUSS SOME PRACTICAL, "WHAT HAPPENS IN YOUR OWN LIVING ROOM", EXAMPLES OF THIS NEW GEOMETRY OF SOUND. YOU KNOW WHAT WOULD HAPPEN AS WELL AS I DO. MOST PEOPLE WOULD NOT WASTE TIME EVEN READING THE FIRST CHAPTER AND MIGHT THROW IT AWAY BEFORE DISCOVERING SOME OF THE PRACTICAL USES. SO I HAVE LEANED HEAVILY ON YOUR OWN GOOD INTUITION TO INTRODUCE SOME OF THE PRACTICAL RESULTS OF THIS NEW LOOK AT THINGS WITHOUT GETTING BOGGED DOWN IN TECHNICALITIES.

GEOMETRY, TO MOST OF US, MEANS THE TEDIUM OF AXIOMS AND POSTULATES WE HAD TO OVERCOME IN OUR TRIUMPHAL MARCH THROUGH SECONDARY SCHOOL. A DEFINITION OF WHAT THIS IS WOULD BE, "THE SCIENCE THAT TREATS OF THE SHAPE AND SIZE OF THINGS". THIS DEFINITION IS BORROWED FROM MATHEMATICS DICTIONARY, BY JAMES AND JAMES, PUBLISHED BY VAN NOSTRAND REINHOLD CO. IN THE MORE TECHNICAL SENSE GEOMETRY MEANS MORE THAN THIS. THE DEFINITION WHICH ENCOMPASSES WHAT WE NEED IN ORDER TO UNDERSTAND THIS NEW AUDIO IS, "THE STUDY OF INVARIANT PROPERTIES OF GIVEN ELEMENTS UNDER SPECIFIC GROUPS OF TRANSFORMATIONS", AGAIN LIFTED FROM THE MATHEMATICS DICTIONARY.

EVERY MAJOR WORD IN THAT SECOND DEFINITION IS RICH IN SPECIFIC MEANING. BUT YOU DON'T HAVE TO BE A MATHEMATICIAN TO APPRECIATE WHAT IT MEANS TO "SOUND AS SHE ARE HEARD".

WE HAVE TOUCHED ON THE FACT THAT THE SOUND IMAGE EXISTS IN MANY FORMS. THAT "THING" WHICH WE EXPERIENCE AS AN ILLUSION OF ACOUSTIC PRESENCE CAN

BE OBSERVED IN ANY OF A VARIETY OF SHAPES AND SIZES. THAT NEW DISC YOU PURCHASE AT THE RECORD STORE HAS IT FIRMLY IMPRESSED AS UNDULATIONS ON A SPIRAL GROOVE. WHEN YOU PLAY THE RECORD BY PLACING IT ON A TURNTABLE AND SCANNING THE GROOVE WITH A PHONOGRAPH CARTRIDGE YOU ARE TRANSFORMING THAT IMAGE FROM ONE FORM INTO ANOTHER. EVERY STEP OF PROCESSING THIS SIGNAL IS ALSO PERFORMING A TRANSFORMATION, IN TERMS OF OUR DEFINITION OF THE GEOMETRY OF THE SOUND ILLUSION.

ABSTRACT CONCEPT? YOU BET, IF YOU'RE LOCKED INTO EITHER THE COMPLETELY OBJECTIVE OR SUBJECTIVE VIEW OF AUDIO AND ARE NOT CONCERNED WITH MEASURING WHAT YOU HEAR AND CONVERSELY. BUT TO THOSE WHO WANT TO BRING LISTENING AND MEASURING TOGETHER IT OFFERS AN EXCITING NEW HOPE.

WHAT WE MEAN BY "TRANSFORMATIONS" IN THIS LOOK AT AUDIO IS "WHATEVER IS DONE TO THAT THING WHICH WILL ULTIMATELY BE THE PERCEIVED ACOUSTIC IMAGE". A MICROPHONE, OR AMPLIFIER, OR LOUDSPEAKER IS A THING PROVIDING A TRANSFORMATION OF THE SOUND IMAGE. THAT'S PRETTY OBVIOUS. BUT THERE ARE OTHER TRANSFORMATIONS WHICH AT FIRST GLANCE APPEAR SO ABSTRACT THAT HAD WE INTRODUCED THEM EARLIER, YOU MIGHT FIND THEM HARD TO ACCEPT.

TAKE FOR INSTANCE THE MAKING OF A DISC. A GLOB OF HOT VINYL IS PLACED BETWEEN STAMPER PLATES WHICH THEN PRESS DOWN, WAFFLE IRON FASHION. UPON RELEASE, COOLING AND TRIMMING, A FRESH RECORD EXISTS.

PRETTY STRAIGHTFORWARD. BUT THAT IS A TRANSFORMATION, IF YOU LOOK AT IT FROM THE GEOMETRY OF SOUND. IF THE STAMPING PROCESS HAS TEMPERATURE CYCLE DIFFICULTIES OR THE VINYL IS NOT PURE, OR THE STAMPING HAS DIFFICULTIES OF ONE FORM OR ANOTHER, WE KNOW THE DISC WILL NOT COME OUT AS INTENDED. IN TERMS OF WHAT WE HAVE DISCUSSED SO FAR, WE CAN SAY THAT A DISTORTION HAS BEEN INTRODUCED IN THE TRANSFORMATION. THIS STAMPING PROCESS DISTORTION IS EVERY BIT AS MUCH OF A DISTORTION AS HARMONIC DISTORTION IN

AN AMPLIFIER, ALTHOUGH THE EFFECT ON THE RESPECTIVE END PRODUCTS MAY NOT AT FIRST GLANCE BE EVEN REMOTELY ALIKE IN FORM OR SUBSTANCE.

ONE ADVANTAGE OF LOOKING AT THINGS IN A BROADER PERSPECTIVE AS WE ARE DOING, IS THAT WE CAN OBSERVE GENERIC SIMILARITIES IN PROCESSES WHICH WERE FORMERLY HANDLED AS INDIVIDUAL PROBLEMS. PERHAPS THIS IS NOWHERE MORE EVIDENT THAN IN CONSIDERING THE DISTORTIONS WHICH CAN BE INTRODUCED IN TRANSFORMATIONS, OR MAPPING FROM ONE FORM TO ANOTHER. THE BIGGEST PROBLEM THIS CREATES IS THAT WE SUDDENLY BECOME AWARE OF SO MANY ALLIED THINGS IN THE AUDIO PROCESS THAT IT IS DIFFICULT TO TIE ONESELF DOWN TO CONTEMPLATE ONLY ONE DISTORTION AT A TIME.

THE DIFFICULTY OF TRYING TO DEFINE THE TERM "DISTORTION" IS THEN BETTER HANDLED BY CONSIDERING WHAT HAPPENS DURING A TRANSFORMATION AND PROJECTING THAT DEFORMATION FORWARD TO THE FINAL SOUND IMAGE. HAGGLING ABOUT THE MEANING OF A GIVEN PERCENTAGE OF HARMONIC OR INTERMODULATION DISTORTION IN A TAPE RECORDER VERSUS AN AMPLIFIER MAY THUS BE SEEN TO BE WASTED LABOR UNLESS WE COMPARE THE EFFECT ON THE PERCEIVED SOUND IMAGE. SOME OF THIS WE HAVE SAID BEFORE BUT IT IS SO IMPORTANT IT BEARS REPEATING.

WHAT ARE SOME DISTORTIONS THAT MAY BE INTRODUCED IN AN AUDIO PROCESS WHICH WE MIGHT NOT HAVE SERIOUSLY CONSIDERED BEFORE? STAMPING AND VINYL IMPERFECTIONS ARE CLEARLY CAPABLE OF INTRODUCING DISTORTION. THAT "TICK" WHICH INTRUDES WITH METRONOME PRECISION AT AN ADAGIO RATE IS A DISTORTION OF THE SOUND IMAGE - YOU BETTER BELIEVE IT. IT MODIFIES THE IMAGE BY INTRODUCING AN ATONAL DISTURBANCE NOT RELATED TO PROGRAM MATERIAL BUT TIED TO TURNTABLE RATE. THIS DISTURBANCES EVEN HAS SPATIAL VALUES AS IT MARCHES ACROSS OUR STEREO STAGE.

HAVE YOU EVER HEARD A RECORD WITH A SLIGHTLY OFF CENTER HOLE?
PRETTY AWFUL. THE TEMPORAL SCALE OF THE SOUND IMAGE IS MODULATED AT
A LOW RATE AND THIS COUPLES INTO THE TONAL PROPERTIES IN A DISTRESSING
MANNER. PURE DISTORTION.

A WORN OUT STAMPER CAN LOSE THE HIGHER FREQUENCIES ON THOSE RECORDS
WHICH ARE PRODUCED FROM IT. THE SHARP EDGES OF GROOVES ON THE RECORD ARE
ROUNDED OFF. UNDER A MICROSCOPE THIS SEEMS TO BE A PURE MECHANICAL
PROBLEM. BUT CHASED BACK TO THE FINAL SOUND IMAGE IT SHOWS UP AS A
LOSS OF TOP END.

HOW ABOUT RECORD WARP? MAYBE THERE WAS A LITTLE VINYL MEMORY IN THE
PRESSING, OR THE RECORD WASN'T HANDLED PROPERLY, OR WE GOOFED AND GOT IT
TOO HOT. THE EFFECT IS THE SAME, THE RECORD IS WARPED. WHAT KIND OF
DISTORTION IS IT? CONSIDER THE FINAL SOUND IMAGE. THE TIME AND TONAL
PROPERTIES OF THE SOUND IMAGE ARE WARPED, AS YOU CAN READILY TELL BY
LISTENING TO PIANO MUSIC. A SUBSONIC VERTICAL COMPONENT IS TRACED BY THE
STYLUS. THIS CAN GET ALL THE WAY THROUGH TO THE SPEAKER AND NOT BE CAPABLE
OF CAUSING SERIOUS DISTORTION IN THE AMPLIFIER CHAIN. BUT IF THE SUBSONIC
ENERGY CAN CAUSE OVERLOAD IN THE WOOFER, WE HAVE DISTORTION. IN SEVERE
CASES THE SOUND ILLUSION CAN BECOME PULSATILE IN SPACE AND TIMBRE, LIKE
A CLEAR OPTICAL REFLECTION FROM A BOWL OF GELATIN THAT IS RHYTHMICALLY TAPPED.

THERE ARE MANY MORE DEFORMATIONS OF TRANSFORMATION WHICH WE CAN NOW
BEGIN TO IDENTIFY AS DISTORTIONS. PRINT-THROUGH ON MAGNETIC RECORDINGS
IS ONE WHICH WE CONSIDERED IN AN EARLIER DISCUSSION. THAT MODIFIES SOME
GROSS TEMPORAL VALUES. A SIMILAR PROBLEM IS LATERAL PRINTING. MAGNETIC
TRANSFER CAN TAKE PLACE NOT ONLY FROM ONE LAYER TO ANOTHER BUT ALSO ALONG
THE DIRECTION OF THE TAPE ITSELF. A SUDDEN, SHARP SOUND IN THE ACOUSTIC
IMAGE IS MANIFEST AS A HIGH FLUX SPACE-GRADIENT ON THE TAPE. THIS CAN

"PRINT" LATERALLY WITH NOTICEABLE PROBLEMS IN THE FINAL SOUND IMAGE.

THE MOST OBVIOUS DIFFICULTY IS A LOSS OF "EDGE" OF INSTRUMENTS. BRASS DOES NOT "BITE" AS IT DID WHEN THE TAPE WAS FIRST MADE. CERTAIN TIME-PERIODIC WAVEFORMS, SUCH AS DUE TO RATCHET - SOUND PERCUSSION, CAN HAVE THE SOUND ALMOST DESTROYED BY A TEMPORAL BLURRING, IN EXTREME CASES OF LATERAL PRINT.

THIS NOW INTRODUCES A TYPE OF DISTORTION WHICH FEW PERSONS MIGHT HAVE CONSIDERED BEFORE - AGEING. YES, OLD MAN TIME CAN TAKE HIS TOLL ON RECORDS AND TAPE. THIS IS A GENUINE TRANSFORMATION, ONLY NOW TIME ENTERS INTO THE PROCESS. JUST AS HEAT CAN WARP A RECORD, AND A CARELESS MECHANICAL HANDLING CAN SCRATCH A RECORD, SO CAN TIME MODIFY THE SOUND IMAGE. ALL OF THESE ARE DISTORTIONS DUE TO TRANSFORMATION. NORMALLY ONE'S OWN RECORD AND TAPE COLLECTION IS NOT ENDANGERED BY THIS DISTORTION IN TIME TRANSFORMATION (AGEING) BUT ARCHIVE RECORDS HAVE A REAL PROBLEM. THE AGEING TRANSFORMATION CAN INTRODUCE EXTRANEOUS PROGRAM MATERIAL (NOISE, PRINT THROUGH, ETC.) AND CAUSE A REPRESENTATIONAL DISTORTION IN THE SOUND IMAGE WHICH MODIFIES SPACE, TONAL, INTENSITY, AND TEMPORAL VALUES.

THERE ARE MANY, MANY MORE TRANSFORMATION PROBLEMS WHICH WE CAN NOW IDENTIFY AS CAPABLE OF DISTORTING THE FINAL SOUND. THESE VARY FROM IMPROPER BIAS ON THE MASTER TAPE RECORDER, THROUGH IMPROPER FACET ANGLE IN THE CUTTER STYLUS, TO TRACKING ERROR IN THE REPRODUCING PHONOGRAPH. ANY ATTEMPT HERE AT A COMPREHENSIVE LISTING OF THOSE DISTORTIONS WHICH CAN BE IDENTIFIED WOULD PRODUCE A VERY LENGTHY REPORT. THAT IS NOT THE PURPOSE OF THESE DISCUSSIONS, WHICH ARE INTENDED AS INTRODUCTIONS TO THESE NEW CONCEPTS IN AUDIO.

BESIDE THE OBVIOUS IDENTIFICATION OF DISTORTIONS WITH WARPING OF THE SUBJECTIVE IMAGE, WE CAN MAKE USE OF OUR NEW FOUND TOOLS OF ANALYSIS TO RECOGNIZE GENERIC SIMILARITIES IN DISTORTION. THIS LETS US USE SOME SOLUTIONS WE HAVE ALREADY WORKED OUT FOR ONE TYPE OF DISTORTION AND APPLY THEM TO OTHER DISTORTIONS WE MAY NOT HAVE BEEN ABLE TO HANDLE ADEQUATELY. THE RECOGNITION OF ISOMORPHISM, THINGS OF THE SAME FORM, WILL BE OUR NEXT TOPIC IN THE MYSTERY OF AUDIO.