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The Art of Cymbal Making

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The Art of Cymbal Making

The art of cymbal manufacturing is dependent on precise measurements and expert craftsmanship. Every step in the cymbal making process is performed in a certain way to create a specific sound. The art of cymbal making is a complex process that can only be mastered after years of self-training or an apprenticeship. As an essential part of the drum set, and one of the loudest instruments; understanding the idiosyncrasies of cymbals is not only important to drummers, but to all musicians as well. Also, for audio engineers, understanding the frequency space and loudness of cymbals can benefit any audio engineer or producer. These characteristics of a cymbal are all purposely created through the manufacturing process and can be defined by analyzing their output. Certain companies have mastered the art of cymbal manufacturing and others are currently innovating this process. With a seemingly infinite amount of manufacturing techniques and combination of elements, the possibilities of types of cymbals appear endless. While the amount of cymbal tones is always changing, cymbal variety was not always this abundant in music. In fact, when cymbals were first invented, they weren't even used as a musical instrument.

The first appearance of cymbals in history dates so far back that there is no definite date for when and where they were first designed. Historians believe they
may have been invented during the 14th century within Eastern Asian cultures “where soldiers scared the living daylights out of their adversaries with a cacophony of clashing cymbals” (Pinksterboer). This technique is something that has not faded away over time. In orchestral scores, cymbals are used to startle audiences or represent fearful noises such as thunder or an angry sea.

Overtime, the technique of startling people by crashing cymbals together spanned beyond the battlefield and began to be used in entertainment and music. An interesting thing about the history of cymbals is that they caught on rather quickly with other cultures and began to spread to all parts of the world. It wasn’t until around the 17th century that cymbals began finding their way into orchestral settings, but they were not taken seriously by the composers of the time: “The German Composer Nicolaus Strungk was the first to use cymbals in an opera orchestra in the year 1680. Hector Berlioz was probably the first composer who had a suspended cymbal played with sticks” (Pinksterboer). Even though Berlioz was ahead of his time with his suspended cymbal invention, he never took his cymbal mounting idea seriously and is quoted as saying, “The combined sound of a cymbal and a bass drum was only fit to have monkeys dance to” (Pinksterboer). Meanwhile, in Turkey, Turkish artisans were becoming experts at cymbal manufacturing, and the “music spread by Turkish military bands (Janissary music) was characterized by noisy and rhythmic instruments such as the bass drum, the side drum, cymbals, the triangle, the tambourine and the bell-tree” (History).

The Western composers took notice of how Turkey was using cymbals in their music, and they specifically requested that cymbals be brought in directly from
Turkey instead of attempting to make them themselves: “Christoph Willibald Gluck asked for them in his opera Iphigenie en Taurhide. The best-known example of an early use of cymbals in western culture is probably Wolfgang Amadeus Mozart’s Turkish opera from 1782, The Abduction from the Seraglio” (“History”). This adoption of cymbal usage from east to west is what laid the foundation for the formation of some of the most well known cymbal manufacturers in the world today.

Some cymbal makers travelled west themselves: “From Istanbul to Boston, in 1908, Avedis Zildjian found his way to America where he opened his very first factory, a candy factory“ (Pinksterboer). The now well-known cymbal company, Zildjian, was just a small cymbal manufacturer in Istanbul. It wasn’t until Avedis received a letter from his uncle, Aram Zildjian, to take over the company in the late 1920s that the company began expanding. “Avedis was happy selling candy in America, but it was his mother that convinced him to set aside the candy and use his factory for cymbals.” (Pinksterboer)

This was a fortuitous time to bring the cymbal manufacturing to the United States because “jazz was developing all over the United States, and so was the art of performing drums on a full drum kit. The timing to enter into the cymbal manufacturing market couldn’t have been any better” (Pinksterboer). It was also during the early 1900s that cymbals were becoming a permanent and necessary part of the drum kit. Early jazz and ragtime drummers were the pioneers of mounting cymbals to drum kits. Even though the timing to enter the cymbal market was perfect, the Zildjian business started slow, but things changed when a drummer
ask Avedis to make a thinner 12” cymbal: “Drummers loved the results, according to Armand Zildjian: Kruoa, Papa Jo Jones, Chick Webb, were just a few of the popular drummers of the era to adopt the thinner cymbal style. They were all wild about these new thin cymbals” (Pinksterboer). The lightweight, bright sounding cymbal was exactly what drummers were looking for.

With sudden success, Zildjian then began to expand their cymbal catalogue: “In 1948, the Avedia Zildjian catalog simply listed 20 cymbal sizes, ranging incrementally per inch from 7 inches to 26 inches, available in Paper Thin, Thin, Medium Thin, Medium, Medium Heavy, and Heavy” (Pinksterboer). Also during this time, all Zildjian cymbals were handmade, so each cymbal came with a note that read “sizes cannot be guaranteed to be accurate.” (Pinksterboer)

With the expansion of cymbal sizes, Zildjian began developing different types of cymbals because “by the late 1940s drummers began to evolve and more cymbals were needed. Drummers started using their cymbals to keep time instead of keeping time on their snare. The demand for different styles of cymbals was there and through this demand, Zildjian developed the ride cymbal and the hi-hat cymbals” (Pinksterboer). It may have gone unnoticed by many, but the creation of new cymbals revolutionized drumming forever in music. Most drummers today could never imagine playing drums with only one, thin 12” cymbal. Cymbals have always progressed as music has progressed, but it was the invention of different cymbal styles where cymbals really made a noticeable mark on music.

As the 1950s and 60s rolled through, jazz was taking a back seat to the birth of rock and roll: “The first rock drummers played the same cymbals that their jazz
colleagues used. The undefined shhhh sound on 1960s pop records was not by choice; it was just all there was and that was definitely not enough to cope with amplified guitars” (Pinksterboer). Zildjian so encountered completion as “a cymbal company from Switzerland called Paiste entered into the American cymbal market. Paiste prided itself on louder cymbals and released a new series of cymbals created specifically for rock music called the Giant Beat Series” (Lustenburger).

The louder cymbal design called for bigger and more durable cymbals. Zildjian was forced to also come out with their own version of rock and roll cymbals. During this time Zildjian and Paiste were the only two big name cymbal companies that drummers could go to. It wasn’t until the 1980s that the cymbal market received an injection of competition and innovation. Everything changed for cymbal manufacturers when a Turkish cymbal maker introduced an entirely new way to make cymbals: “In 1981, Robert Zildjian founded Sabian, probably the fastest growing cymbal company ever” (Pinksterboer). “Sabian took the cymbal market by storm by giving drummers variety. There wasn’t a Sabian ride cymbal; there were fifty different Sabian ride cymbals. Sabian developed a cymbal for all types of music and for all types of drummers. The cymbal market took notice of Sabian’s meteoric rise and cymbal manufacturers began popping up all over the United States, imitating the Sabian “variety” cymbal manufacturing style.” (Pinksterboer, “The Cymbal Book”) The big companies like Zildjian and Paiste had to keep up and began offering a variety of cymbals to customers. The cymbal market had officially become just as important as the drum market.
“Meinl, a cymbal company from Turkey, is currently on a meteoric rise and becoming the cymbal of choice for some of the world’s most well known drummers. During the time of Zildjian, Paiste, and Sabian, Meinl was a small, unknown cymbal company in Turkey. Like Sabian in the 1980s, Meinl is using innovative alloy formulas in their cymbal manufacturing that have never been used before. Success in the cymbal manufacturing market comes down to the recipe of alloys and design technique.” (Pinksterboer, “The Cymbal Book”) So, the invention of cymbal variety amongst big name cymbal manufacturers led to cymbal companies using different mixes of alloys to create their large variety of cymbals.

These alloys are what give cymbals a specific sound and allow cymbal manufacturers to develop a wide variety of cymbals. Overtime, cymbal companies have patented their formulas of alloys and manufacturing techniques to give their cymbals their companies’ signature sound. This has opened up the market to hundreds of cymbal companies who think they have the best recipe for manufacturing cymbals. This is what makes cymbal research so important. Knowing what types of alloys are being used reveals the sound the cymbal manufacturers are trying to produce. Also, understanding manufacturing techniques of well-known cymbal companies, as well as smaller cymbal companies, informs drummers of the sound they should expect from any given cymbal. For any drummer, it is important have the ability to define and elaborate on the manufacturing process of cymbals and the significance it holds with sound they produce.

The definition of an alloy in its most basic sense is: ” a blend of two or more metals.” “Since metals are not chemically bonded in their natural state, they are
fused and alloys are created in a molten state through melting and mixing” (Brennan). “In cymbal manufacturing, these alloys are copper-based. In some cymbal's alloys, copper is mixed with bronze, brass, tin, or silver. These metals are chosen due to their sonic qualities when mixed with copper and it is the choice of metal that also decides the price of the cymbal.” (Brennan)

Cymbal makers choose copper-based alloys “because of the malleability of copper and it has the most desirable sonic properties. The most common copper alloys used in cymbals are bronze alloys, which are alloys of copper and tin with trace amounts of other metals such as silver” (Brennan). It is these combinations of other metals that give cymbals their name. For example, a B20 cymbal is 80 percent copper and 20 percent bronze. A B8 cymbal would be 92 percent copper and 8 percent bronze. The major cymbal companies often attach these names to their cymbals to show the consumer exactly what they’re getting in a cymbal. Sabian and Meinl boast a B20 on a lot of their cymbals, however, “B20 can be difficult to work with, requiring extensive reworking and annealing due to its natural brittle state, but it has been used longer than any other alloy” (Brennan).

Other companies take different approaches: “Paiste commonly uses the CuSn20 label on their cymbals, which states 80 percent copper and 20 percent tin. Zildjian however remains a mystery and labeling their cymbals with the words, secret alloy” (Brennan). While all these companies have their secrets, it easy to have a secret when you are working with alloys. A B20 cymbal does consist of 80 percent copper and 20 percent bronze, but really it is 80 percent copper alloy and 20 percent bronze alloy. For example, “bronze alloys are often fused with tin, zinc, and
phosphorus. Bronze is considered a bell metal when fused with a 20-25 percent tin content and can be characterized by its sonorous quality when struck” (The Editors of Encyclopedia Britannica). These alloys are mixed with certain amounts of specific metals and then combined to give each cymbal its special sound, which comes from a special recipe, and that is where the secret lies.

Billy Brennan, writer for *Modern Drummer Magazine*, explains why every detail of cymbal manufacturing is incredibly important to developing the sound of any cymbal.

While the alloys used by cymbal companies provide the foundation for the sound of the final product, they’re only hitting the tip of the iceberg. A finished cymbal and its overall sound is the result of the craft skill: hammering patterns, tempering, and different lathing techniques. Each manufacturing step, besides the size, weight, and shape, affects the sound of a cymbal.

Each cymbal company or cymbal-smith has their own process for manufacturing a cymbal. So, there is no exact way to make a cymbal, but techniques can be shared.

Craig Lauritsen, a self-employed cymbal smith, lists a few of the steps in his manufacturing process. Lauristen works with B20 blanks, which are metals melted and mixed into a cymbal shape, but that have yet to be hammered, tuned, and lathed. Lauristen explains his cymbal manufacturing process:

Applying heat to a B20 blank will affect the temper of the cymbal and make it brittle and prone to cracking. The heat will need to be set to at least 200 degrees. Hammering is basically cold impact hardening of the bronze that
should be started as the metal cools. The hammering can alter the sonic characteristics of the cymbal and create a musical instrument. Lathing a cymbal will further this tuning creating equal-distant lines around the cymbal for the sound to bounce off the cymbal equally.

Cooling and heating the cymbal are also manufacturing techniques that will affect the overall sound. All cymbal companies differentiate in their heating and cooling processes because this process plays a major role in the sound quality of the cymbal.

Impression Cymbals performs their heating and cooling techniques using coal fire and temperature regulated pools:

Impression Cymbals melts their special B20 formula in 50 kg pots with very precise measurements using coal fire. This is done so that the cast bronze that goes into a slow burning wood oven obtains carbon to retain the metals elasticity. The molten metal is poured into molds in order to produce basic cymbal blanks in various sizes. The cast blanks are repeatedly run through rolling machines and re-heated. This process is repeated until the aimed size and thickness is reached. The cymbals are finally shocked in a pool of water at the highest temperature possible. Impression Cymbals believes this technique is the best way to ensure the quality of melted bronze.

("Manufacturing Process")

Since heating and cooling is an important step to creating the cymbal’s overall sound, some companies have alternative methods for this step. Sabian describes their heating and cooling method as a natural process:
The alloys are mixed at the end of everyday, poured into a casting to give it shape, and brought inside to cool down overnight. These shaped castings are cooled by the open air and are not touched until the next day. From there the castings are reheated 7-12 times in 1400-degree ovens. The cymbals are heated over and over until the metal naturally spreads itself out. Once the cymbals are thin enough to be hammered and lathed, they leave them out to cool down in the open air for another night. ("Genuine Sabian" 17)

Once cymbals are melted and cooled, the real craftsmanship and labor-intensive skill begins. Zildjian discusses how their cymbal-smiths craft a cymbal once it has been shaped and cooled:

A cymbal craftsman places the cymbal on a lathe, where the outer layer is removed and tonal grooves are carved into the cymbal. The depth and position of the grooves is dependent on the cymbal type. A cymbal craftsman at Zildjian must complete a five-year apprenticeship to acquire the skills necessary for this step. (Slagle)

Five years sounds like a long time for learning how to lathe a cymbal, but the learning process is necessary due to the dangers and value lathing presents in the cymbal making process: “A lathe is a potentially dangerous machine that must be treated with respect and all possible safety precautions when using it” (Lauritsen).

Lathing is based upon the make-up of the cymbal. The type of alloys used to create a cymbal determines the speed at which the lathe spins. Faster speeds are used for harder, thicker alloys and slower speeds are used for the softer and more brittle cymbal types. A self-employed cymbal manufacturer, Craig Lauritsen, elaborates
further on the lathing process for his cymbals: "For B20 alloy cymbals, safety and cutting efficiency works best at 200 to 350 rotations per minute. The B8 alloy cymbals are a softer alloy, and require 180 rotations per minute or less to cut and shape" (Lauritsen). “Basically, every tool you use in the Lathing process is going to have an impact on the final sonic outcome of the cymbal” (Lauritsen).

Lauritsen explains the importance of the cymbal lathing process:

The shaper, which cuts the grooves in the cymbal, can have a sonic impact on the sound of the cymbal based upon the material it is made out of and the angle at which it is set to cut the grooves. The speed of the lathing machine generates more heat to the cymbal for lathing, which can alter the sound of the cymbal. With this in mind, the lather can determine how the grooves will be implemented into the cymbal by the lathing machine. The grooves can create more tension in a cymbal, whereas a smooth surface generates a splashier, less sharp, cymbal sound. When a cymbal is being lathed, it generally loses tension, but creating the right set of grooves in the lathing process can compensate for the tension loss and create more tension, making the cymbal have a sharper sound than it originally had. A tense cymbal will have a faster response, longer sustain, and a greater prominence of higher frequencies. It is these intricacies of the lathing process that demand such a long training process to become a cymbal craftsman. It is also the lathing process that allows for such an extensive variety of cymbals to be developed by cymbal manufacturers.
While the cymbal craftsman is still necessary for the lathing process, most companies have a machine that does most of the hammering and sizing. One big-name company that does not fully rely on the machine to do the hammering is Paiste. "While Paiste still uses a machine to hammer their cymbals, there is a person controlling the velocity and the speed of the hammering. This is done in order to retain the human element of cymbal manufacturing." (Lustenberger) Paiste elaborates further on their technique and why they still retain the human element of cymbal making:

The hammering department gives the cymbal its shape by using a pneumatic hammer. This tool aids the craftsman in the initial shaping of the cymbal. With his feet the craftsman controls the velocity force, and with his hands the spacing pattern of the hammering. The process is comparable to mastering four-way independence in drumming, extensive and careful hand hammering using only hammer and anvil to accomplish the fine-tuning of the shape (Lustenberger).

It is the nearly infinite combination of alloys, lathing patterns, and cymbal designs that have led me to analyze and research how the output of a cymbal is determined by these factors. I took five different cymbals of similar proportions from Sabian and Zildjian and measured their output on the frequency spectrum while noting their alloys, lathing patterns, and measurements.

**Cymbal Analysis**

For my cymbal testing, I used the Slate Virtual Microphone System. I placed the microphone 22 inches from the cymbal and hit each cymbal individually. Each
The Slate microphone was routed into the Slate VMS preamp and no software emulations were used. The preamp was then routed into the Lynx Aurora 16 for analog to digital conversion at a sample rate of 96 kHz and bit depth of 24 bits. The signal was then recorded into Pro Tools 11 HD. In order to match the loudness on all recorded cymbal hits, all audio files were normalized to a peak of -3 db.
Through these recorded cymbal hits, I measured the sonic quality of the following cymbals: an 18” Sabian AAX, a 16” Sabian AAX, a Paiste 17”, a Zildjian K 16”, a Zildjian ZBT 16”, and a Zildjian ZBT 18”. Each of these cymbals had been previously used, but none of them had any significant cracks or dings that could alter the sound. Individually, each cymbal was different in weight, lathing pattern, and alloy mixture. It is these aesthetic differences I am looking to see reflected and measured in the sonic quality of each cymbal. In order to have a visual representation of the sonic quality of each cymbal, I used a Waves PAZ Analyzer plug-in on each cymbal track. Once I had the sound of each cymbal recorded, I ran the soundwave through the PAZ Analyzer plug-in and captured the frequency response and RMS of each cymbal hit.

The frequency response on the PAZ Analyzer is measured using decibels on the y-axis to determine loudness and hertz to measure frequency levels on the x-
axis. The RMS of each cymbal hit is measured in decibels full scale (dBFS) that reflect the average loudness of the cymbal hit. The frequency response and RMS both accurately and mathematically define the sonic quality of the cymbal.

The frequency response can be visualized to give a closer look at the characteristics of a cymbal. Looking at the frequency response, the balance of high frequencies and low frequencies in the sound wave reveals how well the cymbal sustains a quality sound when a drumstick strikes it.

With today's almost infinite variety of cymbals, harshness is a sound intentionally used by cymbal manufacturers in certain cymbals in order to cut through other sounds and stand out. So, the more the unbalanced the frequencies are, the harsher the sound becomes. This harsh sound is a line cymbal companies walk by increasing the amount of high frequencies in their cymbals in order to make their cymbals splashy, bright, fast-attacking, or explosive. On the other side of the spectrum, cymbals with a more sustained low end in their frequency response are referred to as dark, rich, soft, or warm. These are terms I will be referring back to as I analyze each cymbal’s frequency response and RMS.
The first cymbal I analyzed was the 18” Sabian AAX.

The first spike in this cymbal’s sound wave is at 250 hertz, indicating its lowest frequency. The loudness is steadily climbing in dB and the lower frequencies have some sustain to them on the sound wave, with some slight fluctuations. The higher frequencies, in the 2k hertz – 6k hertz range, have less sustain, which give the cymbal its harsher sound. At about 3k hertz the loudness has peaked, making 3k hertz the frequency where this cymbal will be most prominent in reference to the sound of an entire drum kit. The frequency response starts to attenuate drastically at 7k hertz with only minor fluctuations. The high frequency roll off is nice on this cymbal because it has a smooth sustain as it goes down in volume in the high
frequency range. It is the sustained levels of the low frequencies, balanced with the harsher high-mid frequencies that give this cymbal an overall rich and bright sound.

This frequency response and rich and bright sound are reflected in the lathing patterns found on the 18" Sabian AAX.

On this cymbal the lathing pattern is laid out relatively thin at the bell of the cymbal. From this point in the lathing pattern, after each smooth row, there is a row of deeper lathed lines. This is done to retain some tension and sharpen the splashier sound generated from the smoother lines. Further outward from the bell, the thinner lathed lines become smaller and the deeper lathed lines become wider. This tension in the lathing pattern is reflected in the frequency response because the fluctuation in loudness is minor over most of the frequency spectrum. The characteristics of the frequency response match up with the physical characteristics of the cymbal.
The next cymbal I analyzed was the 18” Zildjian ZBT. In comparison with the other 18” cymbal, there are some similarities and some drastic differences. The similarities would be the frequencies at which the soundwave first spikes and the frequency at which both cymbals peak. Both cymbals have sound waves that spike around 250 hertz and peak around 3k hertz. The drastic differences in these cymbals frequency responses are the loudness of certain frequencies and the amount of loudness and the balance of high and low frequencies over the frequency spectrum.

The 18” Zildjian ZBT’s sound wave first spike just under 250 hertz, but by 250 hertz it is already 10 decibels louder than the 18” Sabian.
The 18" Zildjian ZBT remains somewhat louder than the 18" Sabian throughout the frequency response. Also, there is more fluctuating in loudness in the mid-to-high frequency range than the 18" Sabian AAX. This would generate an even harsher sound than the 18" Sabian. The 18" Zildjian ZBT starts to fluctuate rapidly at around 800 hertz, making these frequencies stand out. The fluctuating frequencies stand out more because of the rapid drop and rise in loudness. The more fluctuating soundwaves jab or jolt out specific frequencies instead of sustaining or sizzling a frequency with a more stable soundwave that has less fluctuation.

This differs in comparison to the 18" Sabian that starts to fluctuate rapidly at its peak point of 3k hertz. Also, the fluctuations in loudness are more drastic in the 18" Zildjian ZBT. The 18" Sabian fluctuates between 2 to 3 decibels, while the 18" Zildjian ZBT fluctuates between 10 to 20 decibels before reaching its peak loudness. Once the loudness has peaked, the fluctuations become minor and the sound waves starts to attenuate around 7k hertz. The attenuation has a smooth, sustained roll off after 7k hertz. This frequency response is a reflection of a splashy, bright cymbal. This cymbal is loud and cutting because it has more fluctuations of higher frequencies than sustained ones. There is some warm sustain in the lower frequencies, but there is a larger amount of fluctuating middle and high frequencies on the cymbal’s sound wave. The physical make-up of the 18" Zildjian ZBT also reflects the splashy and bright output of the cymbal.

The 18" Zildjian ZBT is the same size as the 18" Sabian, but that is about the only similarity in the physical make-up of these two cymbals: “The 18" Zildjian ZBT is made up of 92% copper alloy and 8% tin alloy, while the 18" Sabian consists of
80% copper alloy and 20% bronze alloy” ("Zildjian ZBT Crash Cymbal 18"). The alloy make up of these cymbals is evident in their frequency responses. A tin alloy is often used to give the cymbal a brighter sound; while the bronze alloy is bright as well, it is more easily manipulated to create a darker sound during the manufacturing process of the cymbal.

Not only are the alloys of these cymbals drastically different, but their lathing style differs as well. The 18” Sabian features an unlathed bell, with thin and thick lathing patterns going outward from the center of the bell. The 18” Zildjian ZBT has consistent lathing across the cymbals. The lathe lines are not too thin or thick across the cymbal. This is done to create a splashier, more piercing cymbal tone because the sound is not as sharp as it would be if it were running into deeper lathed lines across the cymbal. This lathing pattern is also consistent with frequency response and the fluctuating loudness. The more fluctuating there is, the splashier and brighter the cymbal will sound. The 18” Zildjian ZBT is a splashy, bright cymbal and the frequency response, along with the physical make-up, confirm these characteristics of the cymbal. So, when comparing cymbals, the alloy make up and lathing design are important factors to know, especially when deciding what type of cymbals should be used for certain types of music.

The next cymbals I analyzed and compared were three cymbals of the same size, the 16” Zildjian K, the 16” Zildjian ZBT, and the 16” Sabian AAX. Each cymbal was designed to be a fast-attacking crash, so the frequency responses should bare similar results. The 16” Zildjian K starts much like all the other cymbals by having its
first spike in the sound wave at 250 hertz on the frequency spectrum. Also, the RMS is -17.3 dB, which is very much like the RMS of the other cymbals.

The frequency response shows the lower, warmer frequencies being loud and sustained from 300 hertz to 800 hertz. Interesting enough, the fluctuation in loudness begins just after 800 hertz. This would give the cymbal a somewhat distorted, warmer sound by harshening these low middle frequencies, which is uncommon for a cymbal meant to be a bright, cutting crash. However, the harshness of a bright, cutting crash is evident in the frequency response as the loudness fluctuates more rapidly around 1.7k hertz and peaks at around 5k hertz. The attenuation of the 16” Zildjian K is relatively smooth and sustained as the high frequencies go down in volume.
I believe the manufacturers at Zildjian wanted to create a cymbal with a harsh fast-attack sound but pair it with some warmer frequencies so the cymbal could appeal to more styles of music. The frequency response does show these warmer frequencies being brought out, almost as loud as the 5k hertz peak frequency, but the high frequency attack is there with the harsh, drastic fluctuation in loudness past 2k hertz up to 5k hertz.

This cymbal consists of “80% copper and 20% tin, with traces of silver, and an alloy Zildjian refers to as their secret alloy” (“Zildjian K 16’ Dark Crash Thin Cymbal: Musical Instruments”). The heavier metal, silver, explains the warmer tones and the high amount of tin shows why this cymbal is so bright sounding at the same time. Another interesting part about this cymbal is the lathing pattern. The lathing pattern is extremely thin and just barely indents the smooth surface of the cymbal. This is done to give the cymbal some harsh, splashy sound to allow it to have that fast attacking aspect when a drumstick strikes it.

Also worth mentioning, the Zildjian K’s are a very popular cymbal amongst drummers because they are so tactfully made. The specific amounts of silver applied to the formula to create darker sounds, and the light lathing pattern used to create a splashier output all contribute to the popularity of the Zildjian K cymbal and the sound it generates. This cymbal is very well balanced from the precise amounts of dark and bright metals used to peak at both ends of the frequency spectrum, to the lightly applied lathing pattern to allow those peak frequency levels to ring out.
The next 16” cymbal to be analyzed and compared is the 16” Zildjian ZBT. This cymbal is very different from the other cymbals by generating its first spike in the sound wave at around 7k hertz.

An interesting thing about the frequency response of the cymbal is that it is not even similar to the frequency response of the 18” Zildjian ZBT. This frequency response shows how much difference 2 inches of cymbal can make to the sound quality.

For this cymbal, the frequencies had more sustain than fluctuations in frequencies. This would generate more of a ringing of higher frequencies rather than a sizzle or splash of high frequencies. The fluctuations in the higher frequencies really weren’t there until the loudness peaks at around 5k hertz and the fluctuating stops quickly at 8k hertz. The rest of the frequency response was smooth, with only
minor fluctuations. The peak loudness is similar to the other 16” Zildjian at 5k hertz, but there is not as much fluctuating in the frequency response to really bring out a large number of high frequencies. This cymbal is still loud and cutting, but it differs from the other cymbals because the majority of the frequencies will be sustained and ringing instead of splashing.

The cymbal make up of the 16” Zildjian ZBT is exactly the same make up as the 18” Zildjian ZBT. “It is 92% copper alloy and 8% tin alloy with identical lathing patterns over the bell and across the cymbal” (“Zildjian ZBT Crash-Cymbal – 16”). This is what is so surprising about how different the two cymbal’s sound waves are. This differs from the 16” Zildjian K because of the small amount of tin alloy used and the thicker lathing pattern. The amount of tin is consistent with the loudness of the higher frequencies, but they are much shorter than the 16” Zildjian K. So, in comparison, both cymbals have a peak loudness in the 5k hertz range, but the amount of higher and harsher frequencies is greater in the 16” Zildjian K.

The next 16” cymbal I compared and analyzed was the 16” Sabian AAX. This cymbal is different from all the other cymbals by generating its first spike in the sound wave at 500 hertz.
It also differs from the other cymbals by being slightly louder than most with an RMS of -16.6 decibels. More specifically, the frequency response is different from the 16" Zildjian ZBT and the 16" Zildjian K because of the first spike in the sound wave. The first spike in the sound wave is at 500 hertz, sitting in the middle of the frequencies of the first spikes of the other cymbals. The 16" Zildjian K spiked around 250 hertz and the 16" Zildjian ZBT spiked around 800 hertz.

The 16" Sabian AAX has a lot of sustain up until 1k hertz. At 1k hertz, the cymbal starts fluctuating more, creating some harsher tones, but at 3k hertz it starts to have more sustain than fluctuations at the higher frequencies. The loudness peaks at 4k hertz and slowly attenuates at 7k hertz. There is some slight fluctuation
in the higher frequency range to add some splashy sound to the cymbal, but those higher frequencies are more sustained than fluctuating.

The frequency response of the 16” Sabian AAX is similar to the 16” Zildjian K when it comes to the warmer, low-mid frequencies. The 16” Zildjian K offers lower, warmer frequencies, but the 16” Sabian AAX has more volume in the lower frequency range. This commonality of warm frequencies is where these two 16” cymbals differ from the other 16” Zildjian ZBT. However, the 16” Sabian AAX and 16” Zildjian K differ when it comes to the higher frequencies. At 2k hertz the 16” Zildjian K fluctuates in loudness the most, harshening those bright, splashy cymbal sounds. The 16” Sabian AAX fluctuates up in loudness at 2k and sustains that loudness at the higher frequencies, with only minor fluctuations, resulting in the higher frequencies ringing, rather than splashing. So, while the 16” Zildjian K is harsher in the higher frequency range, the 16” Sabian AAX is smoother.

Both the 16” Sabian AAX is very similar to the 16” Zildjian K contain “80% copper alloys and 20% tin alloys with traces of silver” (“Sabian AAX X-Plosion Crash Cymbal – 16’ Brilliant Finish”). These cymbals are also similar due to their lathing pattern because the lathing is very light and thin. Both of these cymbals feature a lathing pattern that is meant for a splashy, bright output. The frequency response shows the warm qualities of the silver and the splashy, bright high frequencies from the lathing pattern. The 16” Sabian AAX and 16” Zildjian K differ drastically from the 16” Zildjian ZBT.

With all three 16” cymbals in mind, the 16” Zildjian ZBT is the outlier. It is not as warm as the other two 16” cymbals and it is not as bright either. The 16” Zildjian
ZBT is a softer cymbal in comparison to the other two. It cuts through with the high frequencies, but those high frequencies are very brief. The 16” Zildjian K has a harsher, brighter attack sound than the other two 16” cymbals. Also, the fluctuations in loudness are much larger at high frequencies than the other two cymbals. The 16” Sabian AAX is softer and smoother than the 16” Zildjian K because it sustains the higher frequencies, rather than fluctuating them to create a harsh, bright sound. The 16” Sabian AAX sustains and rings-out the higher frequencies, while the 16” Zildjian K makes those frequencies fluctuate and sizzle. Each of these cymbals is intended to cut through everything else, but each cymbal cuts through the noise in its own unique way.

I consider cymbal research to be important knowledge to acquire because cymbals are an essential part of the drum set and also one of the most expensive. Through this research gained a better idea of creating a cymbal of my own. I have an idea for creating a cymbal attachment, mainly for the hi-hat. This idea can be used for other cymbals and other drums, but for this design I would like to specifically focus on the hi-hat. This idea is easier to understand if I draw it, but for the sake of imagination, I will try to describe it.

I would like to design a smaller cymbal, shaped like a slice of pizza that is attached to the hi-hat rod, just above the hi-hat cymbal. This attachment would be designed to capture the upstroke of the drummer and add an additional note to the tempo. It would be similar in texture, design, and thickness to the hi-hat, but only smaller. I have always wanted something like this, but I have yet to see anything on the market similar to this.
At the very least, I would like to have a cymbal attachment that can capture the upstroke of a drumstick for myself, but if I could design something that all drummers could use that would be even better. It is my curiosity and passion for cymbals that has led me to do this research and write this thesis.

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