On Research

MANUFACTURING SECRECY: THE DUELING CYMBALMAKERS OF NORTH AMERICA

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OBJECTIVE RESEARCH CAN BE A problem when confronting the canonized history of any organization, be it industrial, political, or religious. Some of the highly successful corporate giants of the music industry have acquired oral traditions that reflect market appreciation for their musical products, and yet their narrative details may be at odds with interpretations of their history that employ more independent methods of study and analysis.

In this comparative look at the continent's two cymbal manufacturers, time-honored company doctrine infuses a spectrum of production technologies to present a compelling case of seemingly unintended musical symbiosis. Every effort has been made to keep this study dispassionate and even-handed, no easy task given the stature that these firms enjoy among percussionists.

INTRODUCTION

The manufacture of cymbals is a small, highly specialized, and exceedingly vigorous undertaking today, involving about a half-dozen bronze-working factories in the United States, Canada, Europe, Turkey, and China. Their common goal is the creation of instruments tailored to the evolving tastes and abilities of percussionists worldwide.

Two of the cymbalmakers, the Avedis Zildjian company of Norwell, Massachusetts, and Sabian Ltd. of Meductic, New Brunswick, trace their roots to the workshop of a 17th-century Armenian alchemist and his secret method of casting bronze.[1] Today, that secrecy claim is coupled with a record of over three centuries of cymbal production and a highly competitive atmosphere in the modern drumming marketplace. Such attributes present a compelling opportunity for the field of industrial archeology to undertake the comparative study of historic industrial enterprises at the height of their productive capacities.

The opportunities in industrial site research when the site is a flourishing concern are obvious. firsthand contact with the practitioners of a historic production process, eyewitness observation of tool and machine usage that the examiner of abandoned sites is denied, and scrutiny of the interaction between the site and its social, economic, and technological settings. Such priceless resources, however, are tempered by access restrictions and strategic industrial behavior toward competitors that have the potential to distort the material record. And the experience of the Zildjian and Sabian cymbal factories adds the management of trade secrecy to this mix of enticements and site dilemmas. How may a legally protected trade secret be understood through the material evidence without appearing to interfere with industrial practice?[2] What ethical standards guide independent historians when research results seem to affirm or refute the validity of a host site's market presentation?

I have sought to address these questions, and others related more directly to cymbal manufacture, through a study of the two cymbal manufacturers in North America, using tours of the factories, interviews with factory workers and officials, an examination of promotional advertising, and a look at the cymbals and how they relate to the traditional production of gongs. Another level of inquiry, focusing on the experiences and beliefs of musicians who work with Zildjian and Sabian cymbals, awaits further research.

THE CYMBAL

As with other percussion instruments, cymbals have been classified as idiophones, rigid instruments struck, plucked, blown, or shaken to produce musical effects caused by the vibration of their primary elements.[2] The abrupt, shimmering sounds of cymbals have been used to punctuate the music of ancient Mediterranean civilizations, the performance of religious rites, and the symphonies of European Romantic composers.[3] Since the 1920s, cymbals have been standard equipment on the drum sets of professional musicians. Other markets exist in military drum corps, scholastic marching bands, and symphony orchestras.

The one-piece copper-alloy construction of cymbals, their apparently standardized dish-like form, and their seemingly simplistic supporting role in the musical repertoire suggest a rather undistinguished "primitive" lineage well removed from the rarefied subtleties of Stradivarius violin-making and Steinway piano construction. Historically, the elite stringed and keyboard instruments have received the lion's share of reverent study by musicologists continually sifting through and re-consecrating the various shop pedigrees.[4] But the special requirements placed on cymbals for musical brilliance, resonance, and overtones have sparked an equally illustrious heritage of distinguished achievement in developing material compositions and cymbal forms, especially in the 20th century.[5] Over the last 30 years, the profusion of modern musical styles and methods of electronic sound amplification have been pushing cymbal innovation to an unprecedented degree.

As with most musical instrument-making grounded in long tradition, the manufacture of cymbals has been craft-centered and remains concentrated largely among a handful of family-owned factories possessing knowledge and experience accumulated over several generations, along with idiosyncratic methods of production and strong name recognition within the trade. Today the

principal cymbal manufacturers are (alphabetically): Istanbul of Turkey, Meinl of West Germany, Paiste of Switzerland, Sabian of Canada, UFIP of Italy, Wuhan of the People's Republic of China, and Zildjian of the United States.[6]

The two basic cymbal forms are termed Turkish and Chinese, the former dominating the field with its uniform concave shape and deep, resonant tones. Chinese or "China Boy" cymbals have prominently upturned rims, deep crowns, and produce sharp, high, "trashy" sounds when struck. These cymbals, which probably originated in ancient China, are offered as special-effects instruments by most cymbalmakers.[7] Turkish cymbals are subdivided into many classes, distinguished by diameter (6 to 30 inches), depth of profile, weight, and methods used to work and finish the metal. Types range by weight from the French, Viennese, Germanic, and American matched pairs for orchestral and marching band use to the ride, splash, crash, and foot-pedaled hi-hat cymbals for jazz and rock drumming.

While Turkish and Prussian military bands, Armenian church rituals, and European orchestras sustained cymbalmaking as it was practiced in Turkey through the 19th century, evolving American musical tastes shifted the cymbal craft westward, propelling cymbals to their present position as indispensable counterpoints to the bass drum, snare drum, and tom-tom, the latter two worked with the same hardwood sticks and brushes that strike the suspended cymbals. The rise of ragtime and vaudeville routines at the turn of the century helped move cymbals from the hands of marching soldiers to the trap sets of seated drummers in the days of (suitably named) Tin Pan Alley. The frequent shifting of the timekeeping role of the snare drum to the "ride" cymbal to sustain the musical beat spurred the integration of cymbal beats into popular compositions. Cymbal forms mushroomed in the 1930s, with larger, thinner cymbals appearing in the drum sets of jazz and swing band luminaries such as Gene Krupa, Jo Jones, Chick Webb, and Lionel Hampton.[8] Through the 1940s and 1950s, cymbalmakers developed a near-continuous stream of new cymbal forms to accent the be-bop, Dixieland revival, Motown, and country-western musical styles.

The electronic ferocity that characterizes cymbal usage in today's high-decibel rock bands has opened up the biggest market yet for drummer's cymbals. Both the acoustic requirements of the rock drummers and the sustained brutality of the stickwork they administer have forced makers to introduce cymbals with extremely durable structures and broad dynamic ranges. Drummer set-ups requiring up to a dozen different cymbals are not uncommon, ranging from small "splash" cymbals to the explosive "power crash" cymbals designed to penetrate through the loudest instrumentation.[9]

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Despite such evolutions in usage, with consequent impacts on levels of production and manufacturing sophistication, the cymbal metal and the forms it takes have remained relatively constant, products of long-standing tradition and the fortunes of one cymbal-making family.

THE FAMILY

Among musical instrument makers and percussionists, the name Zildjian identifies one of the most venerable production records in musical history. In 1992 the Avedis Zildjian Company will record its 370th year in cymbalmaking, a history dating from 1623. The family identifies that year as the beginning of their involvement with cymbals, when an ancestor—according to company lore, an alchemist working on the outskirts of Constantinople—discovered a process that significantly strengthened a mixture of copper and tin to produce an extremely durable yet highly musical cymbal. The family surname presumably was acquired in recognition of this mastery; "zil" the Turkish term for cymbal, "dji" denotes smith or maker, and "ian" the Armenian suffix indicating "family of" or "son of." According to numerous secondary accounts of the firm (no primary sources are known to survive) the cymbalmaking methods were passed through the generations, the process being communicated orally to the eldest son, brother, or nephew, and occasionally through wives, daughter, and nieces.[10]

One Zildjian helped open up the European market to Turkish cymbals with award-winning showings of his cymbals at the expositions of 1851 and 1862 in London, of 1863 in Paris, and of 1888 in Vienna. Zildjian cymbals also received recognition at an 1883 exposition in Boston and at the 1893 World's Columbian Exposition in Chicago.[11] With the help of scores by Hector Berlioz and Richard Wagner that showcased the special qualities of Turkish cymbals, Zildjian products found a permanent place in the instrumentation of the full orchestra.[12] The leap to drum sets occurred with the help of martial bands from which many other instruments also were borrowed to embellish stage routines and highlight circus performances with easily transported music kits.

In the late 1920s a branch of the family immigrated from Turkey to the United States (by then the Zildjians' principal market) to establish a cymbalworks in Quincy, Massachusetts, south of Boston. In 1972, after some fifty years of growth under the leadership of Avedis Zildjian III, the shop relocated to a larger plant in Norwell, 20 miles from Quincy, where today daily output hovers at around one thousand cymbals.[13]

Soon after the death of the elder Zildjian in 1979 at the age of 92, a split occurred between his two sons, Armand and Robert, both heirs to the firm and recipients of their father's knowledge of "the secret." A court settlement reached between the brothers passed the Norwell plant and Zildjian trade name to Armand, while to Robert went a sum of money and a secondary Zildjian plant in New Brunswick, Canada, established in 1968 as a foundry for one of the company's more specialized lines of cymbals.[14]

Today, both factories carry on a vigorous manufacture and rather ferocious rivalry, operating at full production quite independent of one another. According to their figures, the Norwell plant fills some 60 percent of the worldwide cymbal demand,[15] while the Meductic operation (christened Sabian after the first two letters in the names of Robert Zildjian's three children—Sally, Billy, and Andy) targets its daily output of several hundred cymbals at specific segments of the hard rock and orchestral markets. Few major drum shops in the United States, Canada, Europe, and Japan are without their Zildjian and Sabian display racks, featuring cymbals with distinctive surface finishes and company logos, but embodying the family's same cymbal-making know-how. The production methods employed at both factories have many similarities, but significant differences also exist, revealing the kind of technological diffusion that can occur with the break-up of a tradition-bound industrial enterprise, when central figures in the operation go off to make their own variations of the same product.

THE SECRET

Both the Avedis Zildjian Company and Sabian Ltd. employ the device of trade secrecy to proclaim and to shield the processes by which their bronze cymbal alloy is cast and treated. In elliptical phrases in their advertising, the firms refer to a "process," the "sequence of steps," the "make-up," "seasoning," and "the way we combine the metals," to describe what goes on behind the closed doors of the foundry melt rooms in Norwell and Meductic.[16]

The mix itself is stated by both firms to be a B20 bronze (80 percent copper, 20 percent tin) with traces of silver, the standard composition of bell metal.[17] The high tin content adds musical resonance and compressive strength to cast bells and cymbals, but when subjected to the tensile stresses experienced by cymbals it becomes a liability if the metal is not properly heat-treated.

Unsuccessful experiments allegedly conducted early in the century at Kohlert & Sons, a musical instrument works in Czechoslovakia, and later at the Massachusetts Institute of Technology and at Wurlitzer Organ Company in Buffalo, New York, were aimed at replication of the Zildjian alloy, according to popular accounts of the firm at mid-century.[18] Although unverified, the apparent failure of each attempt to reproduce the "Zildjian sound" or even a high-tin cymbal that did not shatter like glass has added to the mystique of the product and helped validate the existence of an actual physical distinction between the family's cymbals and those of other cymbalmakers (who, the Zildjians claim, are capable of using no more than 12 percent tin). Adding a lurid character to the tale is the often re-told, faintly alchemical saga of Karekin Zildjian. Outside the direct line of inheritance, this Zildjian stole away to Mexico City in 1907 to set up his own cymbal foundry. His experiments ended abruptly in an explosion that tore his head off and "encased his body in molten bronze."[19]

More official validation of the secret came in the 1950s with a series of United States court cases in which the association of the family name with a secret method of making cymbals was claimed by both the American Zildjian firm and another U. S. firm that owned one of the family's former cymbal factories in Turkey.[20] The court opinions in these cases relied on a 1939 judicial definition of a trade secret: "Any formula, pattern, device, or compilation of information which is used in one's business, and which gives him an opportunity to obtain an advantage over competitors who do not know or use it."[21]

Trade secrets, like patents, embody exclusive knowledge, but unlike patents, may be guarded long after commercial exploitation has begun. Among manufacturers, trade secrets have become a legally accepted means of indefinitely shielding proprietary information from potential competitors while endowing a product with an enigmatic aura. Little empirical data exist on manufacturing methods protected as trade secrets since no central registry for them exists, as it does for patents. Only when litigation occurs or when the presence of trade secrecy becomes a component of an advertising campaign does the method emerge, as with Coca-Cola and Kentucky Fried Chicken.[22]

As Eric von Hippel has discussed in his recent study of innovative knowledge, such monopolies on technical information work only when innovations can, in fact, be kept secret, either by using technical barriers within the product or by hiding manufacturing processes from public view.[23] No protection exists against the discovery of a trade secret by accident or by reverse engineering. Only when it can be proven that a trade secret has been divulged through unfair or dishonest means (theft or breach of contract) may the exclusive use of a trade secret be rescued.

The metal arts have been especially susceptible to declarations of trade secrecy, given the man-made properties worked into virtually every commercial metal. Samurai sword tempering, high-speed tool steels, and the fabrication of Swiss Army knives have passed through periods of trade secrecy, and during much of the 20th century the Veeder-Root Company of Hartford, Connecticut, cast a shroud over its Veeder Metal alloy to restrict knowledge of the means used to impart its vacuum die-casting properties (agitation of the molten tin alloy with sticks of pitch pine.)[24]

The belief cultivated over the years by the Zildjian family that their secret was a by-product of the pseudo-scien-

tific mystical world of 17th-century Armenian alchemy, while undisputed, tends to overlook the fundamental requirements of all specialty production metals for fine controls and careful sequencing to which only small communities of artisans and production metallurgists have historically been privy. Non-members of these fraternities, especially those of an artistic persuasion, may be considered especially receptive to claims of secretive craft ingenuity since such claims reinforce a larger desire to believe in the uniqueness of all artistic expression.

The ongoing hagiography surrounding the Zildjian family alloy, together with physical security arrangements at each of the foundries, suggest that they take their secrecy claim very seriously indeed.[25] As with certain microelectronics manufacturers who "pot" their circuitry in insulation materials that cannot be penetrated without destroying the circuits themselves,[26] Zildjian and Sabian manipulations of metal may or may not be revealed through a laboratory analysis of the metal. The inability of other modern cymbalmakers to reproduce the musical effects for which the family's cymbals are known suggests that total comprehension may require more than a routine study of the cymbal's microstructure or the remelting of the metal to withdraw its constituent elements, a procedure that would destroy critical evidence of grain boundaries and crystallization.

A heavy steel door is rolled shut and a red light flashes outside to ward off unauthorized entry when casting is under way in the Norwell foundry. In Meductic, a village of some 200 people in a remote corner of New Brunswick, casting occurs in a building detached from the main Sabian plant. At either site, only a small cadre of trusted longtime employees handles the mixing and pouring. (Today, Zildjian family members occupy executive positions, although many have been schooled in the manufacturing process.)

"Our secret's not in the composition," Armand Zildjian once told a newspaper reporter. "It's not a written-down thing or a recipe. It's a technique you have to watch and learn over time, like the cake that Grandma made."[27] Invariably, such allusions coming from both Zildjian and Sabian officials refer to the grain structures of their cymbals, a consequence of events that occurs during casting. This sense of accumulated know-how and hands-on sensorial understanding of a craft process places the Zildjians squarely within a tradition of industrial self-reliance, associating the acquisition of exclusionary non-academic shop knowledge with the personal hazards and creative challenges of the open forge. James J. Davis, Warren Harding's secretary of labor, captured this sense of shop-floor achievement over the conventional standards of professionally trained engineers in his recollections of worklife in his father's iron foundry: "This [iron puddling] process was handed down from father to son, and in the course of time came to my father and so to me. None of us ever went to school and learned the chemistry of it from books. We learned the trick by doing it, standing with our faces in the scorching heat while our hands puddled the metal in its glaring bath."[28]

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The recent activity of another cymbal-maker, M. M. Paiste & Sohn, of Rendsburg, Switzerland, suggests the influential power of the Zildjian craft secrecy approach to cymbalmaking. Paiste's 1989 cymbal literature gives potential buyers of its latest products an inside look at the labor-intensive hand processes used. In 1987 Paiste announced that "after seven years we finally found the new alloy...It is a bronze alloy with qualities that go beyond any current materials used for cymbals by any cymbalmaker—it is a new era of sound metal, it is a giant step for the whole family of percussive instruments." The company quotes drummers who have tested the new cymbals. "I never heard anything like this," says Terry Bozzio. "These sounds are hypnotic. It's a big mystery."[29]

Meanwhile, Meinl Musical Instruments in Neustadt an der Aisch, a small village in the Bavarian mountains of West Germany, has infused aspects of its high-technology cymbal production line with secrecy claims focused largely on the computer programs that control the hammering machines. This relative newcomer to cymbalmaking (established in the 1950s) has sought to stake out the ultra-high-precision finishing and tuning of cymbals as its own special territory, emphasizing cymbal sound repeatability over the more traditional custom sounds crafted into each cymbal by Zildjian and Sabian.[30]

Ultimately, the question of a cymbal secret's authenticity becomes irrelevant since all that really matters with these products is what drummers believe to be true. To the extent that any cymbalmaker successfully penetrates a chosen market, proclamation of a secretive method is a viable option immune to contrary claims since musical taste rarely is amenable to laboratory analysis.

Unlike such secrecy claims, patented innovations enjoy considerable status and trust among historians of technology as measures of technological growth. Seemingly arbitrary declarations of trade secrecy skirt the gauntlet of full disclosure, critical analysis, and requisite proofs that an inventor's patent application contains something truly novel. Yet the same body of U. S. law that prohibits patent infringement for the purpose of encouraging invention and the "useful arts" also protects trade secrecy insofar as it guards against improper disclosure. In its defiance of an open society's need to render explicit and candid material found in the public marketplace, trade

secrecy plays a spoiler's role, confounding an easy assessment of the innovative process. Tempering the use of trade secrecy as a precision research tool, however, is the lack of any requirement that the content of trade secrets be truly novel or innovative. The secret may be a device or process that is patentable, but it need not be. Trade secrecy protection under law requires only that the owner take effective and ongoing steps to keep the secret secret.

THE EVIDENCE

Tours of the two North American factories (not generally open to the public) reveal that the metalworking processes under way employ the kind of rolling, trimming, stamping, drilling, and turning techniques one would expect to find in a modern bronze-working machine shop. The sonic qualities worked into the product, however, require some production machines and testing methods uniquely suited to cymbals.

In recent years the copper and tin used in Norwell and Meductic have been obtained from South American and North American mines through international metals brokers. At both Zildjian and Sabian, fire-refined copper is preferred over electrolytic or hydrometallurgical copper since useful inclusions remain in copper ores reduced through heat alone, unlike the purer forms of copper reduced through electrical or chemical means. Traces of silver are especially welcome since they occur naturally in certain copper deposits and act as bonding agents with the tin.[31]

During the actual melting and mixing of metals, the all-important casting temperatures, rates of pour, mold preparation, degassing, cooling schedules, levels of oxidation, and other protocols remain hidden behind the doors of the melt rooms, a level of physical security and trust that the family claims has yet to be breached.

Looking like the large purple toadstools without stems, the cymbal castings pass from their open-top steel molds to aging crates outside the melt rooms for several weeks of curing (atomic settling). Annealing ovens then receive the ingots, heating them to 1,500°F (815°C). The cherry-red castings then are mechanically pushed (at Zildjian) or hand-fed (at Sabian) to a three-man roller gang that passes them through a chest-high rolling mill and back into the oven, a process repeated up to 14 times. Each pass through the mill is at a different angle to the previous pass to consolidate the metal thoroughly and overcome the preferred circular orientation of the grain that might generate fractures or warp the cymbals over time.

After another reheat, the nascent cymbals move to pressing machines, first to receive the cup or bell that controls ring and overtones, and then the characteristic Turkish dish form that controls pitch. Before the second pressing stage the cymbals are dropped into a chlorine or saltwater bath to remove oil and dirt and tin oxides, and then are reheated and quenched by being plunged into a tank filled with a cold-water solution that renders the bronze more ductile—opposite the effect that sudden cooling (tempering) has on iron and steel. (Knowledge of the temperatures of cymbal and solution and the amount of time spent in the tank are shop secrets not available to outsiders, although similar quenching methods are practiced by other cymbal and gong manufacturers, as well as silversmiths.)[32] Also, between the two pressing stages, the cymbals are center-drilled or punched to create the hang-holes and then trimmed on a rotary shear to approximate final diameters.

The hammering stage is perhaps the most cymbal-specific in the metalworking sequence. The cymbals are hammered cold, imparting a distinctive voice and character to each instrument. The Norwell plant currently uses three hammer technologies to create their three primary cymbal lines. The K series is for general-purpose drumming and symphonic use, hammered with the random-pattern blows of a conventional floor-mounted blacksmith's reciprocating power hammer. The A series is styled for Zildjian's largest market—rock and jazz drummers—and is hammered in a room full of specially designed pre-set machines that mechanically index the cymbals between half-inch hammer dies to create concentric rings of uniformly spaced dimples from the bells to the rims. The newest Z series, tailored for professional hard-rock drummers, exploits computer programming in a hammer machine also developed in-house that uses star-shaped and pentagonal dies in complex hammered patterns, said to impart extra projection to Zildjian's heaviest class of cymbals.

Sabian machine-hammers its cymbals much like Zildjian's A series, but also offers cymbals that are exclusively hand-hammered after leaving the quenching tank. This labor-intensive craft process requires the use of profile templates cut from sheet steel and traditional bulbous-headed Middle Eastern hand hammers.[33] (The three-pound heads of these hammers are now cast to Sabian's specifications by a Canadian steel foundry.) A four-man crew hammers the cymbals on stake anvils mounted in stumps, shaping the cymbal profiles as they are covered with hundreds of hammered pock marks.

After hammering, most of the cymbals pass to specially designed high-speed faceplate lathes where they are turned (without coolant) to final weights and diameters and faced on both sides to produce clean, bright surfaces and the tonal grooves that focus the sound. (Zildjian's Z series and Sabian's hand-hammered Leopard series are not faced, depending instead on the hammer patterns to control the sound.) Three-foot carbon-steel cutting tools are gripped by the lathe operators, who lock the tools against their bodies while working them back and forth in hinged tool posts across the cymbal profiles. The friction the tool produces administers a final stress-relieving heat treatment to the cymbal. Weighing scales sit near the lathes as the only form of calibration used in this largely free-hand operation. The chips produced at the lathes are either ground up as furnace ignition fuel or hauled off as scrap, unlike the uncontaminated trimmings

and rejects from previous stages that return to the melt room.

The considerable amount of hot-working and cold-working that alters the cymbal metal places in some question both companies' assertions that they are producing "cast" cymbals. Metal work forged from cast ingots typically is not considered cast, given the radical alterations that occur in the metal's microstructure. The only truly finish-cast cymbals in the inventories are Zildjian's tiny finger cymbals, contracted out to an off-site foundry. The firms probably call their principal lines of cymbals "cast" to distinguish them from the stamped cymbals cut from coils of bronze sheet by other cymbalmakers, although those coils may originate from cast ingots as well. Both Zildjian and Sabian offer such stamped cymbals (rolled elsewhere) as less expensive, low-tin alternatives for novice drummers.

Testing occurs in rooms just off the production floors where the human ear remains the only device considered sufficiently sensitive to detect acceptable cymbal tones. According to Zildjian, the acoustic frequencies cymbals emit are identical for both acceptable and unacceptable cymbals. Past attempts to speed up the testing and grading processes through automation were discarded for fear of losing the traditional sounds recognizable to musicians. Sets of control cymbals are on hand to remind the testers occasionally of the proper pitch, tone, range, sustain, and decay levels for a given cymbal series. Some tuning and tonal correction can occur with a return to the lathe, but a percentage of finished cymbals with substantial flaws in sound or appearance (neither company would reveal what percentage) returns to the furnace as scrap. After their purchase the cymbals must be "played in" to reach their fullest tones, a consequence of atomic movement within the metal. Final production steps for most of the cymbals include buffing, die-stamping of the company logo, inking of the series label, and at Zildjian mechanical spraying of a thin lacquer that cosmetically protects the cymbal finish. Sabian leaves uncoated all but their low-tin cymbals.

Unlike the one-room cymbal shops of centuries past, the manufacturing processes today are highly subdivided among the gangs of rollers, pressmen, hammermen, turners, testers, and finishers. Only certain family members and foremen with many years in the shops have a mastery of the entire craft. Both Zildjian and Sabian employ 40 to 60 non-union workers, and although each company enjoys a substantial backlog of cymbal orders, neither factory has chosen to introduce automated systems, beyond Zildjian's computerized hammering machine.

Exclusionary knowledge and the transmission of craft lore have been raised to mass-marketing art forms in the Zildjian and Sabian advertising of the late 20th century.

High levels of quality control evident throughout the manufacturing processes at both plants, including rigorous although unspecified rejection rates, clearly help to maintain and advance each company's reputation, but the husbandry of craft secrecy has proven an indispensable component. Exclusionary knowledge and the transmission of craft lore have been raised to mass-marketing art forms in the Zildjian and Sabian advertising of the late 20th century.

In 1988 the Smithsonian Institution's National Museum of American History acquired collections of trade and promotional literature issued by Zildjian and Sabian. The Zildjian material dates from the 1920s and includes an archives of secondary source material chronicling the enterprise since its inception in Constantinople in 1623. With the family's arrival in Quincy, Massachusetts, in 1929, the cultivation of Middle Eastern craft secrecy and an Oriental exoticism have infused their print advertising, associating Zildjian cymbals with the inscrutable East. Both Sabian and Zildjian continue to use faint but recognizable Arabian Nights imagery in their quest to claim proprietary title to the manufacture of "genuine" Turkish cymbals,[34] while their chief European competitors, Paiste and Meinl, emphasize novel methods of high-technology production and testing. Istanbul, a small firm recently reactivated in Turkey, and Unione Fabbricanti Italiani Piatti Musicali (UFIP), an older firm in Pistoia, Italy, offer short runs of expensive high-tin, hand-hammered cymbals for drummers in direct attempts to capitalize on the notion that the only real Turkish cymbals are those handmade in the region of their birth.[35]

In their current cymbal catalogs, both Zildjian and Sabian introduce their lineups with color images of their casting, hammering, and turning operations. Zildjian includes a prominent photo showing a cymbal in six stages of production, the discolored evolving forms surrounded by work gloves, a cymbal hammer, lathe chips, and a turning tool. Past the pages showcasing their cymbal offerings, the companies present cymbal-player accessories such as cowbells, finger cymbals, sticks, and loose-fitting rivets inserted into holes drilled into the rims of cymbals to create "sizzle" effects. Both Zildjian and Sabian offer their own lines of Turkish gongs, intended primarily for orchestral use. Less direct evidence of the Zildjian and Sabian output is the monogrammed clothing, drinking mugs, towels, and equipment bags emblazoned with the stylized Arabic trade names and boilerplate slogans: "Zildjian: The Only Serious Choice" and "Sabian: Hear the Difference."

But what of the cymbals themselves? Would photomicrographs of Zildjian and Sabian and several other brandname

cymbals reveal the true story? A published analysis of the microstructures of Zildjian and Sabian cymbals, while interesting and in keeping with methods advocated by industrial archeologists, was considered inconsistent both with the limited goals of this research and with the interests of the manufacturers. A decision was made during the course of research not to engage in subsequent metallurgical testing or attempts to reverse-engineer a cymbal, in the belief that the factory and product evidence visible to the naked eye was sufficiently rich to support the level of inquiry posed in this overview.

Enlarged photomicrographs of etched metal have become *de riguer* in recent studies of manufactured metalwares, adding a fashionable legitimacy to the written word, whether or not the photographs actually reveal anything important or even comprehensible to the readership. The cultivation of working relationships with active manufacturing sites is also a goal of industrial archeology. The access gained to proprietary information and facilities includes a level of trust breached at the risk of jeopardizing access by subsequent researchers As has been stated, trade secrecy law does not prohibit the accidental or intentional discovery of trade secrets or even their publication (unless outlawed by contractual agreements). The purposes of this introductory survey leave to others the decision to conduct a metallurgical breakdown of Zildjian and Sabian cymbals, and a presentation of results in appropriate forums

In seeking an underlying basis for a secrecy claim such as that used by the Zildjian family, rather than the secret itself, an important comparative case exists in Southeast Asia, where the methods used in the hand manufacture of traditional Asian gongs have telling similarities to those employed to make cymbals in Meductic and Norwell

THE GONG

As with bells and certain makes of cymbals, the long-standard alloy concentration used in the manufacture of bronze gongs has been copper with the addition of 20 percent or more of tin. While similar in form to cymbals, gongs differ in function, being suspended vertically and struck with padded mallets or human hands.[36]

Today, industrial gong-making is concentrated in the shops of Italy's UFIP, Paiste in Switzerland, and at Zildjian and Sabian. Gong manufacture in the preindustrial foundries and forges of rural Indonesia and elsewhere throughout Southeast Asia has changed little in recent centuries, inspiring a number of research investigations aimed at understanding the principles and practices employed [37] Drawing from recent efforts by ethnomusicologists and archeometallurgists, it becomes clear that the selection of metals and mold material, judgement concerning forging and cooling temperatures, intensity and duration of hand forging, and other variables rest entirely in the hands of individual master gongsmiths, much as knowledge would have rested with the early Zildjians.[38] The lack of an academic or industrial foundation to institutionalize such knowledge renders it automatically subject to secrecy claims

Executed successfully, such a balancing act may invigorate industrial behavior by associating output with the high-craft artistry of a lost age.

In gong shops on the island of Bali, for example, charcoal fires heat gong metal to forging colors identified only by the master smith, typically the scion of a multigenerational clan of gongsmiths. The gong ingots, usually cast from remelted gong shards in stone molds, are lifted to anvil blocks and beaten out over a period of days beneath the sequential blows of up to six smiths' hammers, the gongs directed about on the anvils by the hands of the master smith The many subsequent reheats, quenchings, hammer forgings, scrapings, and voicing stages mirror processes under way at the Zildjian and Sabian factories, the principal differences being in levels of quality control, mechanization, and output.[39]

In 1907, Edward Jacobson and J. H. van Hasselt published a detailed eyewitness account of gong manufacture in Semarang on the island of Java, beginning with the selection of ores and woods from which the furnace charcoal would be made.[40] With no access to spectroscopes, immersion thermocouples, or optical pyrometers to gauge consistency and temperature of the molten metal, quality control during such events would have rested with the smith's ability to "read" the batch by observing such obvious phenomena as color, texture, and brilliance Jacobson and van Hasselt go on to describe how a casting is beaten out into a long, thin strip and bent back on itself as a test of the metal's ductility and suitability for gongs [41]

The various bronze-working knacks employed in the craft manufacture of gongs reflect unwritten skills originally discovered empirically, but readily recast as "trade secrets" when transplanted into an industrial environment Extrapolating from gongs to cymbals and from Southeast Asian craft shops to North American factories of the 1980s is at best an imperfect science, but the comparative scrutiny of such sites and their manufacturing processes can reveal the delicate interplay at work in modern facilities between seemingly contrary forces, balancing a preindustrial handcraft aesthetic with market demands for high-volume production and technological sophistication. Executed successfully, such a balancing act may invigorate industrial behavior by associating output with the high-craft artistry of a lost age. If overdone, the approach may doom the enterprise by labeling it antiquated, out-of-step,

and unresponsive to market forces. The current industrial duel between Zildjian and Sabian clearly serves to enhance both approaches, market promotion of their mystical craft roots and the introduction of advanced metalworking systems, driven by an ongoing race to anticipate the needs and interests of the modern percussionist.

THE DUEL

The archrivalry that has blossomed in the 1980s between the Avedis Zildjian Company and Sabian Ltd. has had the perhaps unintended effect of pushing cymbal innovation in ways that no popular musical trend could have accomplished. Sabian's maverick attempt to carve out a new cymbal market from territory once entirely dominated by Zildjian has resulted in several new generations of cymbals that embody both new levels of technical achievement and the re-emergence of more traditional methods of manufacture that had been abandoned by the family decades ago.

Tours of both factories and discussions with company officials have shown how committed each firm is to the supremacy of its product.[42] Zildjian's strong name recognition and more extensive resources have allowed it to diversify recently into the manufacture of drumsticks, cymbal microphones, and snare drum shells cast from its cymbal metal. Its market leadership in cymbals is maintained with an inventory of over 350 cymbal types and sizes, occasionally embellished with new variations that juggle hammering, turning, and surface finishing methods among their three primary lines.

Sabian has used a smaller workshop and staff (built around a core of former Zildjian employees) to create some novel forms (octagonal) and spun cymbals. In the hammering department, Sabian has returned to the hand hammering of certain classes of cymbals, a claim Zildjian officials question, having long dispensed with the manual practice themselves. My unannounced visit to the Sabian factory affirmed their exclusive use of hand hammers in the production of HH (hand-hammered) cymbals, a telling discovery in such a craft-conscious industry. Zildjian's "hand-hammered" K cymbals are hand-guided beneath a floor-mounted, rapid-striking power hammer, pressed to shape, and then, if needed, touched up with a hand hammer.

While engendering a spirited cymbal competition, the rivalry between the two plants has not helped efforts to preserve significant historical materials. The lack of production records and cymbals from the family's earliest years may be understood through the vagaries of time and cross-cultural emigration, but the loss of documentation associated with the events of this century is less easily dismissed.

Original photographs showing family members working together in the old Quincy foundry have either been lost or cropped to eliminate one or another member from the scene. Selected letterheads and other archival paper have been destroyed, doctored, or are unavailable as historical evidence of what is, according to Dun & Bradstreet, the American industrial enterprise with the earliest start-up date on record (1623).[43] Whether done internally or externally, any attempt to reconfigure a manufacturer's past is regrettable, but is perhaps an inevitable consequence of the breakups, mergers, demolitions, housecleanings, and takeovers that checker and occasionally muddle the industrial heritage. Such upheaval makes all the more critical the role of local, state, and national preservation organizations that have 20th century archival collecting strategies in place in mitigating industry perceptions of old documents and photos as worthless, once their use in advertising campaigns has been exhausted.

CONCLUSION

As in the evaluation of any historic site, nothing can replace the eyewitness examination of site features. But the frantic activity within a modern factory—both on the shop floor and in the offices—can disguise as much as it reveals. On the surface, a living factory offers advantages that are a traditional archeologist's dream. The reading of such kinetic sites nevertheless requires the same skepticism, reliance on outside source material, and comparative analysis that would be needed were the plants nothing but abandoned ruins. Balancing such quests for objective study must be the respect and discretion that all proprietors of historic but nevertheless competitive industries deserve when they allow the outside researcher behind closed doors.

The successful management of a trade secrecy campaign, such as that carried on at Zildjian and Sabian, may in fact reveal more about the market than it does about the metalworking. Without believers, trade secrets cease to have value. The long-standing faith of the cymbal-using community in the "Zildjian sound" testifies to the care with which one family has nurtured its product, linking a mythic past with state-of-the-art sound innovations. The family's new industrial fragmentation, rather than risking dilution of the secrecy claim, seems to be embellishing it with new forms.

The fact that trade secrets, unlike patents, are conspicuous by what they propose to omit from view need not disqualify them as research tools. By their very existence—and market acceptance—unseen technologies demonstrate the high value our society places on an individual's or group's ability to understand and translate phenomena. The intentional denial of potentially innovative technical information is an unexpected and probably intolerable condition to those who rely on reasoned scientific inquiry. But percussionists have no such concerns, depending rather on their ears and the traditions of their profession to judge the worth of a cymbal.

NOTES

[1] Thomas R. Navin. "World's Leading Cymbal Maker: Avedis Zildjian Company," *Bulletin of the Business Historical*

Society 23, 4 (December 1949) 196-206; Chip Stern, "Inside Sabian," *Modern Drummer* 7, 11 (November 1983). 18-23, 88-96

[2] *New Grove Dictionary of Musical Instruments* (London: Macmillan, 1984), vol 1, s. v. "cymbals, drum set;" vol. 2, s. v. "idiophone."

[3] James Blades, *Percussion Instruments and Their History* (New York: Praeger, 1970), pp. 107-109, 192-193

[4] William Henry Hall et. al., *Antonio Stradivari* (1902, reprinted New York: Dover, 1963). Alfred Dolge, *Pianos and Their Makers* (1911 reprinted New York: Dover, 1972)

[5] Blades (n. 3 above)

[6] Rick Mattingly, "Istanbul Cymbals," *Modern Drummer* 12, 5 (May 1988) 112-114, Donald Quade, "Inside Meinl," *Modern Drummer* 9, 2 (February 1985) 22-25, 90-94, Stern (n. 1 above), John McInnes, "Inside UFIP," *Modern Drummer* 12, 10 (October 1988) 30-35, William F. Miller, "Wuhan Cymbals," *Modern Drummer* 13, 5 (May 1989): 41-42, Navin (n. 1 above), Cheech Iero, "Inside Zildjian," *Modern Drummer* 3, 1 (January-February 1979) 12-15, and Iero, "Cymbal Talk with Zildjian's Leonard DiMuzio," *Modern Drummer* 3, 2 (March-April 1979), 20-22

[7] Blades (n. 3 above), pp. 107-109.

[8] Robert B. Breithaupt, "History of the Drumset, Part 1," *Percussive Notes* 28, 1 (Fall 1989) 5-10. The Zildjians assert a high degree of involvement with the great drummers of the Jazz Age and Swing Era, pioneering the full range of cymbal types in use on the modern drum set. See Richard Egart, "Industry Insights: Armand Zildjian, " *Modern Drummer* 10, 5 (May 1986) 26-29, 76-79

[9] *Cymbal Set-Ups of Famous Drummers* (Norwell, Mass.: Avedis Zildjian Company, 1980). Breithaupt (n. 8 above), Part 2, *Percussive Notes* 28, 2 (Winter 1990) 42-45.

[10] The complex Zildjian genealogy appears in part in Stern (n. 1 above). The unknown whereabouts of an early Zildjian family Bible, which charted the growth of the first few generations, leaves a cloud over the identities of all but the 19th- and 20th-century Zildjians. See Navin (n. 1 above), p. 198

[11] Evidence for these expositions' claims rests with emblematic inscriptions on late-19th-century and early-20th-century Zildjian advertising and letterhead stationery illustrated with awards received at the expositions. See also Blades (n. 3 above), p. 171.

[12] Ibid.

[13] Iero (n. 6 above). Output figure obtained from Colin Schofield, Zildjian's marketing manager, in conversation with the author, October 7, 1988.

[14] Stern (n. 1 above)

[15] Schofield (n. 13 above). J. A. Burnett, "Sabian Cymbals, Meductic, N. b., an Alchemist's Legacy," *Equinox* 8, 4 (July/August 1989) 91-99.

[16] These terms are drawn from Zildjian and Sabian advertising literature of the last 20 years. Helping to shroud the secrecy claim in a restrictive environment has been the development of a cymbal jargon that identifies specific cymbal effects: bounce, ping, pang, ride, splash, swish, sizzle, crash, trashy, chip, chirp, and chick.

[17] Robert Zildjian, quoted in Stern (n. 1 above), p. 18, and Armand Zildjian, quoted in Egart (n. 8 above), p. 29; Robert C. Gibbons, ed., *Woldman's Engineering Alloys* (Metal Park, Ohio: American Society for Metals, 1979), p. 193. The 80-20 mix has long been listed in standard metals handbooks as the accepted alloy concentration for cymbals. The data on which this standard is based may indeed be Zildjian's, given the firm's early origins and unquestioned dominance of the trade.

[18] Winthrop Sargent, "Cymbal Player," *Life* 17, 17 (December 23, 1944) 58, 60. Attempts to verify the results of these experiments have not been successful. No records seem to have been retained by the Zildjian company. Their current policy is to discourage such experimentation.

[19] Armand Zildjian, quoted in Peter Gorner, "In Crashing World of Clang and Band, Zildjian Is the Cymbal of Excellence." *Chicago Tribune* (May 18, 1983), sec. 4, p. 4. The addition of water to the molten metal, suddenly producing a large volume of steam, may account for such an explosion.

[20] The line of Zildjian cymbal-making inheritance and company ownership has by no means been direct. In the 1920s the Fred Gretsch Manufacturing Company obtained ownership of both Zildjian firms still active in Constantinople and Bucharest. In the litigation of the 1950s, one of several court cases involving the linkage of the family name with a metallurgical secret is Avedis Zildjian Company vs. The Fred Gretsch Manufacturing Company (December 26, 1956), summarized in *United States Patent Quarterly* 112 (Washington: Bureau of National Affairs, 1957), p. 424.

[21] American Law Institute, *Restatement of the Law of Torts* (1939), vol. 4, sec. 757, comment b (Definition of a Trade Secret), p. 5.

[22] William Poundstone, *Big Secrets* (New York: Morrow, 1983), pp. 13-50; James Pooley, Trade Secrets (Berkeley, Calif.: Osbourne, 1982), pp. 18-19.

[23] Eric von Hippel, *The Sources of Innovation* (New York: Oxford University Press, 1988), p. 54.

[24] George R. Parulski, Jr., *Sword of the Samurai* (boulder, Colo.: Paladin, 1985); LaVerne W. Spring, *Non-Technical Chats on Iron and Steel* (New York: Stokes, 1917), pp. 240-244, Rick Wall, *Swiss Army Knife Companion* (Swiss Army Knife Society, 1986); and Burton Lehrenbaum, *By the Numbers* (Hartford: Veeder-Root, 1966), p. 120

[25] Leonard DiMuzio, "The Avedis Zildjian Story," *Percussive Notes* 28, 2 (Winter 1990) 18-23. On status within the industry, see "Zildjian & Steinway in NAMM [National Assn. of Music Merchants] Hall of Fame," *Music Trades* 137, 7 (August 1989): 116-122.

[26] Deborah Shapley, "Electronic Industry Takes to 'Potting' Its Products for Market," *Science* 202, 4370 (November 24, 1978): 848-849.

[27] Quoted in Gorner (n. 19 above).

[28] James J. Davis, *The Iron Puddler* (New York: Grosset & Dunlap, 1922), p. 91

[29] From Paiste's 1989 cymbal literature. See U. S. Patent 4,809,581.

[30] Quade (n. 6 above), pp. 24, 94.

[31] Schofield (n. 13 above), and conversation with James Hargrove, assistant vice-president for manufacturing, Sabian Ltd., May 29, 1989. Earlier in the 1980s a purer copper seems to have been preferred at Sabian. See Billy Zildjian's comments in Stern (n. 1 above), p. 21

[32] Tsutomu Matsuda, "On the Quenching and Tempering of Brass, Bronze, and Aluminum-Bronze," *Journal of the Institute of Metals* 39 (1928): 67-108

[33] Hans E. Wulff, *The Traditional Crafts of Persia* (Cambridge, Mass.: MIT Press, 1966), pp. 20-29

[34] The Zildjian and Sabian papers (one cubic foot) include magazine display advertisements, cymbal instruction booklets for musicians, drummer biographies, and poster art. They are located in the reference collections of the Division of Community Life. National Museum of American History, Smithsonian Institution, Washington, D. C. 20560. The papers are strongest in 20th-century literature. Earlier materials continue to be sought.

[35] Paiste (n. 29 above), Quade, Mattingly, and McInnes (all n. 6 above).

[36] Curt Sachs, The History of Musical Instruments (New York: Norton, 1940), pp. 240-241; New Grove Dictionary (n. 2 above), vol. 1 s.v. "gongs."

[37] The long working lives and gentle palming of gongs, compared to the brutal punishment administered to cymbals with hardwood sticks, may help explain the limited appeal of gongs to industrial manufacturers.

[38] Paul Champion, "Fabrication of Gongs or Tom-Toms at Un-Chong-Lan, Near Shanghai," in Stanislas Julien, ed., *Industries Anciennes et Modernes de l'Empire Chinois* (Paris, 1869), pp. 66-74; Laurie Rothstein, "Bronze on Fire," *Earthwatch* 4, 1 (Fall 1984): 22-24; Martha Goodway, "High-Tin Bronze Gong-Making," *Journal of Metals* 40, 3 and 4 (March and April 1988): 36-37 and 62-63. See also Martha Goodway and Harold C. Conklin, "Quenched High-Tin Bronzes from the Philippines," *Archeomaterials* 2, 1 (Fall 1987): 1-27 (includes translation of Champion article, pp. 20-24).

[39] Rothstein (n. 38 above).

[40] Edward Jacobson and J. H. van Hasselt, "The Manufacture of Gongs in Semarang," *Indonesia* 19 (April 1975): 134. The low melting point of tin (442°F) relative to that of copper (1650°F) makes its concentration within bronze a function of molten temperature and time during which the bronze remains liquid. Tin content is quickly reduced through oxidation in molten copper.

[41] Ibid., p. 135.

[42] Interviews were conducted at Zildjian on October 7, 1988, with Colin Schofield, marketing manager; Armand Zildjian, president; Leonard DiMuzio, artist relations manager; and Charles Yannizzi, shop foreman. On May 29, 1989, interviews were held at Sabian with Wayne Blanchard, manager of marketing and communications; James Hargrove, assistant vice-president for manufacturing; and Robert Zildjian, president.

[43] Joseph W. Duncan, "Founded: 1787 or Before," *D & B Reports* (September-October 1987): 15, 45. In a Bicentennial project, Dun & Bradstreet searched their start-up date data base for active American industries, irrespective of the nation or form in which the enterprises claimed they first began. Since the survey, Beretta, founded in Italy in 1526, established a gun factory in Accokeek, Maryland.

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