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Microphone Techniques and Sound Reproduction Considerations for the Double
Second Steelpan.

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ABSTRACT

This Caribbean Studies Project explored the inconsistency of the reproduced sound of the Double Second Steelpan in live performance and recording environments. Seven Sound Engineers and Twenty Professional Steelpan Players were interviewed about their experiences in working with the Double Second in both live and recording environments. Five Steelpan Tuners were interviewed about the acoustic function of the Double Second and how it relates to the sound of the instrument when amplified. All their perspectives were compiled and referenced throughout the body of the study. The interviews of Steelpan Professional Andy Narell, and Sound Engineers Michael Low Chew Tung and Mark Wright have been placed in the appendices.

Results from interviews concluded that feedback and leakage on stage were some of the main challenges of reproducing the sound of the steelpan. This study also revealed that skirt noise might be a contributing factor to feedback and, if controlled, could improve the amplified sound of any steelpan. Some tuners have been experimenting with alternative skirt design and materials. Most interviewees agreed that placing the microphone above the pans sounded better in most scenarios and have achieved success to some extent placing the microphones below as well.

Pickup methods, which researched and tested magnetic transducers, were successfully implemented in two steelbands in the late 1980s by Professor Brian Copeland. Results for that research provided a solution for steelpan amplification, and although it was successful, financial difficulties prevented mainstream distribution.

Keywords: Steelpan Amplification, Double Seconds, Microphone Techniques, Live Performance, Steelpan Recording.

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INTRODUCTION

The Steelpan, also called steel drum, or pan, is the newest acoustic musical instrument to be invented in the twentieth century (Taylor). It is classified as a percussion instrument because “the player provides the energy to initiate a vibration by striking the instrument with a stick or similar device...the energy is supplied in a short, sharp burst” (“Creating musical sounds”). It is made from recycling fifty-five-gallon oil drums that are sunk using a ball-peen, or a pneumatic hammer. It is then grooved to separate the notes, shaped to make the playing surface, pre-tuned, and finally burnt to balance the alloys in the metal that would have been offset by the making process. The making of the steelpan has progressed from the ping pong and du-dup to having an entire family of steelpans modelled after a western orchestra.

“The very first pitched steel drums were made from smaller metal containers and were convex in shape...they were still in their experimental stages and had no intentional pitches” (Remy).

The steelpan has gone through several innovations since its invention. Some electronic advancements include the Bertphone and amplified pans¹ created by legendary steelpan tuner²and innovator Bertie Marshall, the Piezo-electric pickups and Lectrapan by Professor Brian Copeland, the Percussive Harmonic Instrument by Panadigm, the ePan by Salmon Cupid, and most recently the Ensoul Pan Pickup. These innovations still struggle to be adopted mainstream.

The Double Second or Alto Pan ranges from E3-Eb6 or F#3- C#6 (see fig. 1.) in the scientific pitch notation system comparable to the range of notes of the piano. The length of the

¹ Amplified pans were pans with guitar pickups attached to them used on Highlanders Steel Orchestra in the 1960s by Bertram Marshal (Slater).

² A steelpan tuner or pan tuner is a person who makes steelpans. Long ago, they would go through the entire preparation process by themselves. Nowadays, the preliminary process of sinking, grooving, and burning is sometimes outsourced.

skirt³ varies between nine to twelve inches depending on the depth of the bowl or sunken area, and the pan tuners' preference. These subtle differences must be taken into consideration when attempting to amplify the natural tone of the instrument. Variables such as type of sticks, type of stand, preparation methods, striking technique, proximity to other instruments on stage, venue or room size, and speakers are factors that also affect the sound output of the Double Second.

In the 1980s, Professor Brian Copeland was successful in improving Bertram 'Bertie' Marshall's steelpan amplification experiments of using guitar pickups on the frontline pans,⁴ by using Strain Gauge, Magnetic, and Piezo-Electric transducers⁵ on the steelpan family. A research paper entitled "Pickup Methods for the Electro-Acoustic Steelpan" was written in the West Indian Journal of Engineering.

Other than research done by Mr. Copeland and The Caribbean Industrial Research Institute (CARIRI) concerning sound reproduction of the steelpan, there is no publication available to the public that discusses microphone techniques with a focus on the steelpan. I intend to follow up on the research that I have done with a symposium or workshop to share my findings with fellow pannists and audio engineers.

³ The skirt refers to the cylinder that is attached to and surrounds the bowl of the steelpan.

⁴ Frontline refers to higher pitched steelpan: - Double Second, Double Tenor, Low and High Tenor, ranging from E3 to F#6.

⁵ According to Collins English dictionary, a transducer is any device, such as a microphone or electric motor, that converts one form of energy into another.

RATIONALE

I have been performing professionally as a pannist playing the Double Second steelpan for the past twenty-five years. I am also a former member of a local steel jazz ensemble, Panazz Players. My experiences in the studio with Panazz Players inspired me to acquire a diploma in recording engineering from the Audio Institute of America.

In solo performances, the sound reproduction of the Double Seconds is not difficult because no other instruments are competing for aural space. In situations like this, some audio engineers express their limited understanding of appropriate microphone techniques for the steelpan. This may be because they do not understand the physics or acoustics of the steelpan. “Most engineers don't know the specifics of these resonances, relying solely on their ears and experience to reveal appropriate mic placement and EQ settings “(Wilkinson).

In a small ensemble comprising steelpan, bass guitar, drumkit, keyboard and guitar, it is sometimes difficult to hear the steelpan amidst the other instruments. One reason for this is that every instrument except for drums and acoustic guitar goes directly to the mixing board, where the signal can be processed effectively. Because there is no standard way of capturing the sound generated by a steelpan, every performance with an ensemble will result in a different sonic experience. The sound output of the steelpan ranges from audible and balanced to struggling for auditory independence.

This research is to compile and share information gathered from experienced steelpan tuners about the acoustic functions of the steelpan, with steelpan players and sound engineers. Information gathered from sound engineers will help steelpan professionals understand how microphone types and setups affect the sound of their instrument. Some industry professionals, through trial and error, have also discovered microphone types and configurations that work well

for the steelpan, but do not have a forum to share their findings. This study is to educate fellow pannists about the relationships between their instrument and the equipment they choose, as well as provide information about microphone choices of sound recording industry professionals and professional pannists. This information may help them achieve better and consistent sound output in various acoustic spaces with their selection of equipment.

THESIS STATEMENT

Title:

Microphone Techniques and Sound Reproduction Considerations for the Double Second Steelpan.

Thesis Statement:

Professional steelpan tuners, sound engineers and players have a wealth of knowledge and experience of instrument acoustics, steelpan construction and tuning, microphone selection and placement, and different acoustic environments. These are some of the factors which contribute to the sound output of the Double Second Steelpan when amplified.

PARAMETERS

This research study focused on microphone selection and placement as it applies to the Double Second steelpan in both live and studio environments. Studio recording sessions were set up to examine different microphone techniques and record any new findings. Due to the availability of the sound engineer and the studio times, only one session was completed. All future appointments made were cancelled due to the restrictions of the COVID-19 pandemic. In addition to studio sessions, field observations of live performances which were planned to examine the practical application of microphone techniques in different environments were negatively impacted by the pandemic restrictions, as all live performances were cancelled.

Scientific analysis of the acoustics of the Double Second steelpan was not done because it is beyond the scope of this study. Scholarly articles were reviewed and compared with information collected from interviews with steelpan tuners to examine any possible agreements or conflicts of information. The perspectives of sound engineers, steelpan tuners, and professional players were gathered through interviews and are highlighted and referenced throughout this paper.

Since most of the interviewees live abroad, personal interviews were not possible. Interviews were limited to platforms such as telephone, email, WhatsApp, and Facebook messenger audio, and video.

OBJECTIVES

The objectives of this study are to:

- Examine the acoustics of the steelpan
- Examine standard microphone techniques when applied to the steelpan
- Feature perspectives of steelpan tuners as is related to the topic.
- Feature perspectives of professional steelpan players
- Feature perspectives of sound engineers who have experience in steelpan sound reproduction
- Feature innovative research findings related to sound reproduction and reinforcement of the steelpan
- Highlight areas where further research is needed

METHODOLOGY

For this Caribbean Studies Project, Microphone Techniques and Sound Reproduction Considerations for the Double Second Steelpan, qualitative research was the method chosen. I chose this method to investigate the inconsistencies faced by professional steelpan players such as myself in live performance and studio environments when amplifying the instrument.

The original plan was to test different microphones, placement, and types of pan sticks in the studio, conduct field observations of the Double Second in live performance settings, in multiple acoustic spaces, in addition to interviewing sound engineers, steelpan professionals, and reading literature related to steelpan acoustics and amplification. I did some preliminary research in September 2019 in the recording studio with Katsunari Imai, testing different microphones and types of pansticks on the Double Second. This recording helped me to notice how loud the additional sounds of overtones and skirt noise were, which prompted me to research the acoustics of steelpan. I did some initial testing of acoustics using a Real-Time Analyzer (RTA) application and two different types of pan stands. Results of the difference in skirt noise were recorded.

To further investigate steelpan acoustics, I interviewed five experienced and well-known tuners: - Augustus Peters, Tony Slater, Denzil Hernandez, Marvin Connor, Jimi Phillip, and Professor Brian Copeland. I interviewed seven sound engineers with more than twenty years' experience working with the Double Second steelpan in both live and studio environments. Their names are Katsunari Imai, Michael Low Chew Tung, Mark Wright, Brennon Virgil, Jason Joseph, Kino Alvarez, and Curtis Marcelle. Twenty local, regional, and international pannists were interviewed about their experiences performing and working with sound equipment and engineers. They are Rudy "Two Left" Smith, Andy Narell, Tracy Thornton, Paul Costa, Mikhail

Salcedo, Johann Chuckaree, Andre White, Jonathan Scales, Curtis Marcelle, Khuent Rose, Sherwin Thwaites, Ravon Rhoden, Kareem Thompson, Greg Charest, Khan Cordice, Kyle Noel, Earl Rodney, Earl La Pierre Sr., Earl La Pierre Jr., and Olujimi La Pierre. Regional and international interviews took place on Facebook messenger audio and video, WhatsApp messenger, telephone, and email. Phone and video interviews were recorded on a cell phone and lasted between twenty to forty minutes. Interview questions were also sent by email, Facebook messenger, and WhatsApp.

Some local interviews were conducted by telephone, WhatsApp, and email due to time constraints and stay at home restrictions associated with the pandemic outbreak of COVID-19. In-person interviews were conducted with Professor Brian Copeland and the La Pierre Family. Due to COVID-19 restrictions and advisories, all field observations and studio recordings experiments were cancelled.

For the transcript of the interview with Andy Narell, see appendix A. For the transcript of the interview with Michael Low Chew Tung, see appendix B. For the transcript of the interview with Mark Wright, see appendix C.

CHAPTER OUTLINE

This study consists of five chapters. Chapter one focuses on the acoustics of the steelpan and other factors that affect the tone of the instrument, as well as highlights official and unofficial research and recommendations made by scholarly articles and pan tuners. Chapter two, entitled *Understanding Microphones and Their Characteristics*, focuses on the characteristics of different types of microphones. Chapter three, entitled *Microphone Techniques*, focuses on standard microphone techniques when applied to steelpan and highlight the recommendations of the sound engineers that were interviewed in this study. Chapter four, entitled *Considerations*, highlights the recommendations made by steelpan professionals who have figured out through trial and error what works for them in both live and studio environments. Chapter five, entitled *Evolution of Innovation*, focuses on a historical overview of technological innovations between the 1970s to the present that is related to the sound reproduction of the steelpan.

LITERATURE REVIEW

There are a few sources that relate to sound reproduction, and several sources related to the acoustics and acoustic behaviour of the steelpan. Available sources include journal articles. The articles are focused on steelpan acoustics and microphone placement. The consistent sound reproduction of the steelpan has been and continues to be challenging for both professional pannists and sound engineers locally and internationally. There are a lot of contrasting views and debates among steelpan professionals and sound engineers about appropriate microphone techniques for the steelpan.

Scientifically supported placement of recording microphones requires knowledge of how the instrument behaves acoustically, specifically, from where does it generate its sound energy and in which directions does the sound energy propagate. Only when this information is known can the optimum location for the placement of microphones be decided. This acoustic behaviour is obtained by studying the sound (acoustic) intensity of the instrument. (Muddeen and Copeland 95)

Variables related to the acoustics of the steelpan include the unique shape, material that it is made from, size of the notes, note positions to one another, shape of the notes, mode shapes⁶, size and type of the grooves⁷, type of sticks, striking technique, length of the skirt⁸, artificial placement of harmonics⁹ by the tuner, and sympathetic vibrations¹⁰ that occur when notes are

⁶ A mode is a standing wave state of excitation, in which all the components of the system will be affected sinusoidally under a specified fixed frequency.

⁷ The grooves on a pan are indentations made with a blunt nail punch and a hammer to create separation between notes and prevent coupling from adjacent notes.

⁹ According to Artopium music dictionary, harmonics are the series of sounds heard when any note is sounded, consisting of the original note, which is the fundamental or first harmonic, then the tone an octave above that called the first overtone (also called the second harmonic).

¹⁰ Sympathetic vibrations are vibrations that occur in the skirt and adjacent notes when a note is excited.

struck or excited. “In studying the vibrational motion of the notes on the pan it was discovered...that the pan operates as a system of non-linear mode localized vibrators” (Achong 2). The information found in this article speaks about the way notes on the steelpan behave when played at loud and soft dynamics and measures the effects that striking technique and choice of sticks have on the sound of the steelpan. When notes on the steelpan are excited or struck, it creates a standing wave. The material makes it difficult to see how the notes and overtones vibrate and how the primary and secondary resonator vibrates in response.

Rossing et al. measured the modal vibrations of notes on two Double Second pans made by two different tuners. The vibrations were illustrated using electronic TV holography. Notes were excited by generating sinusoidal waves that passed through a magnet attached to the instrument. Results on notes, modes of vibration, and harmonics were well documented in this study. Skirt noise was also researched to some extent.

Total radiation from the skirt, in spite of its large radiating area, is considerably less than from the playing surface. However, the vibrational spectrum of the skirt is sufficiently different from that of the note area to influence the timbre of the pan. Damping the skirt markedly changes the timbre (Rossing, Hansen, Hampton 811).

It is possible, however, to dampen the skirt and positively impact the tone of the steelpan without changing the timbre, which will be discussed later in this document.

Derek Gay, senior lecturer, and steelpan researcher, UWI, wrote a paper entitled Finite Element Modelling of Steelpan Acoustics. His research covered the acoustic behaviour of the entire shell¹¹ of Tenor Bass and Six Bass pans and included graphic models of the behaviour of the skirt. He showed the vibrational frequency of the skirt going through eight modes of

¹¹ Shell refers to the playing surface and the skirt of the steelpan.

vibration. Although I could see how the skirt was affected by the vibrations of the notes, the range of the notes on the bass pans was too low to make an assumable comparison to the Double Second pans, which is the focus of my study.

The study of the acoustics of instruments covers how instruments respond to excitation based on shape, manufacturing process, material, modes of vibration, and sound radiation. These variables are essential when determining acoustic behaviour.

In 2002, Professor Brian Copeland and Fasil Muddeen wrote a paper entitled; Observations on Measurements taken of the Sound field of a Clifford Alexis Double Second Pan (Where to (not) put the microphone)¹. Copeland and Muddeen made recommendations based upon exciting one note on the Double Second and measuring the sound field around the instrument to determine areas where a microphone should and should not be placed. This study revealed different radiation patterns when the fundamental note F#3 and the octave F# 4 were excited. There is a need for further research that would show the acoustic behaviour of the Double Second steelpan when other notes located in different positions are excited.

Muddeen and Copeland did additional research using Nearfield Acoustic Holography (NAH) to measure the acoustic behaviour of a Tenor pan. In the paper entitled “Microphone Placement for Tenor Pan Sound Recording,” a list of options were provided for optimal microphone placement, taking into account variables such as the difference in reflective surfaces, microphone types, the distance of microphone to playing surface and number of microphones used. They observed and recorded similarities with the previous study of the Double Seconds concerning acoustic behaviour.

“It is also noteworthy that Copeland's (2002) results and observations for a Clifford Alexis double second steelpan, have also been shown to occur in the Kelman tenor pan

tested for this paper, so that these new recommendations may be applicable to other steelpan instruments” (Muddeen and Copeland 101).

In both papers, the NAH studies were limited to one note on the Double Second and Tenor steelpan. Variables such as proximity to other instruments, type of sticks, striking technique, type of stands and different wall textures were not covered.

Professor Brian Copeland wrote a paper in 1996 entitled “Pickup Methods for the Electro-Acoustic Steelpan” that explored the construction and installation of pickups¹². Strain gauge, Magnetic and Piezo-electric pickups were constructed and installed on steelpans that were donated and field-tested by the Carib Tokyo Steel Orchestra. Copeland aimed to amplify the natural sound of the steelpan without microphones, using the example of acoustic-electric guitars. “Pans are capable of producing audible sound with or without electronic amplification” (Copeland, “Pickup Methods” 41). After successful testing, all ranges of the steel orchestra were supported by the Piezo-electric pickups. Although there were feedback and sound projection issues, “The amplified instruments were received favourably by this group of experienced pannists” (Copeland, “Pickup Methods” 48). The results of this study provided the framework for the design of the M-Series Electro-Acoustic Pans. The M-Series was a very successful research venture which led to the startup of a company called Lectrapan. Lectrapan was unable to produce any pickups for commercial use however, due to a lack of funding.

Except for the Pickup Methods for the Electro-Acoustic Steelpan and the Lectrapan Owner’s Manual, all the literature covered in this review was based on tests and experiments done in controlled environments. All results, therefore, were limited to the acoustics of the experiment environment.

¹² A pickup is a type of transducer that receives mechanical vibrations from an instrument and sends the signal to a speaker.

Part of this Caribbean Studies Project involves a qualitative study of the perspectives of industry professionals such as steelpan tuners, sound engineers and steelpan players. This is an element that is not present in previous research.

CHAPTER ONE

This chapter focuses on the acoustic study of the Double Second pan. It highlights the perspectives and innovations made by steelpan tuners, as well as academic literature related to steelpan acoustics.

To be able to amplify any instrument, one must know about the acoustic properties of one's instrument and how it radiates sound. The Double Second Steelpan comprises two drums and has an average bowl¹³ depth between 160-165 millimetres (mm). The bowl is concave, and notes are raised and slightly convex. This is called the playing surface, where each note is the primary vibrator. The skirt or secondary vibrator has an approximate length of 240mm (see fig. 2). The notes on each pan are organized as two whole-tone scales (see fig. 1), “making it a very symmetrical steel pan... the successive notes of the chromatic scale alternate between the left- and right-hand pans” (“Types of Steel Drums”).

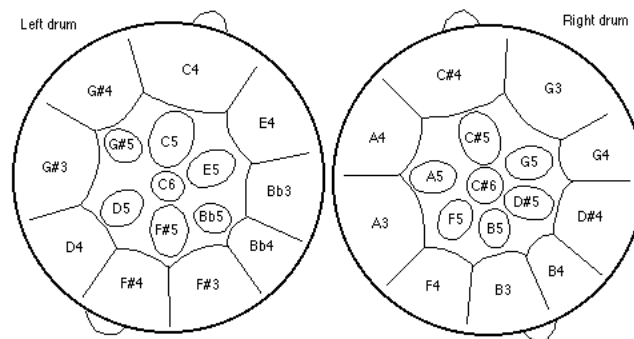


Fig. 1. The layout of Double Second Steelpan

Source: www.caribbean-steel-drums.com/steel-drums-steel-pan-family.html.

¹³ Bowl refers to the sunken area of the steelpan.

When a note is excited on the steelpan, a standing wave is created within the boundaries of the groove, and a sound is heard. Depending on where on the pan the note is excited, it may sound softer or louder. “Many instruments do not emit sound at a uniform volume, even when the player maintains a consistent dynamic level. Certain notes sound louder than others because of the resonances within the instrument” (Wilkinson). This would mean that the lower notes would sound louder than the higher notes because they are closer to the skirt. In addition to this, the bowl shape of the playing surface and the closeness of the notes create sympathetic vibrations with other notes and the skirt, creating what Gay refers to as note-skirt coupling¹⁴.

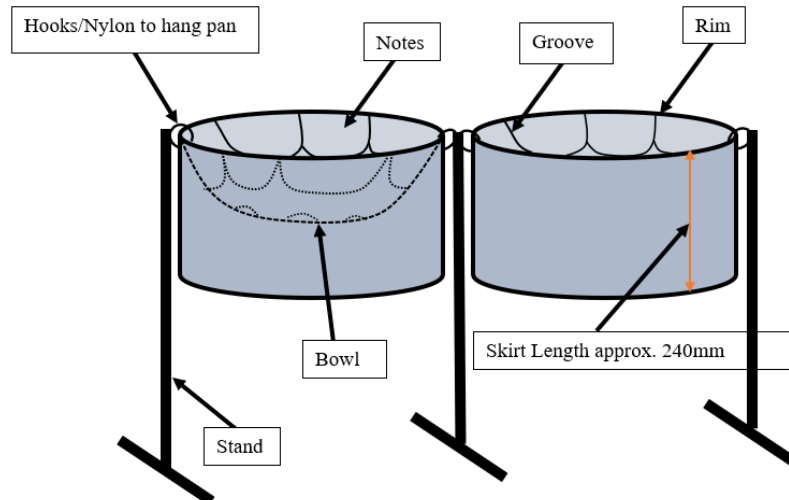


Fig. 2. Side view of a Double Second pan.

Source; Joseph, Natasha. Drawing. 14 Apr 2020. PNG file.

1.2 SKIRT LENGTH AND SKIRT NOISE

Due to the lack of standardisation of the steelpan, the length of the skirt varies among different tuners. The cylindrical shape of the skirt creates a bell-like chamber that produces extra unwanted frequencies and harmonics that is called “skirt noise.” Skirt noise is a non-musical

¹⁴ Coupling refers to the vibrational interaction between the skirt and playing surface when a note or notes are excited.

reverberation or hum that is created when a note or series of notes are played on a steelpan. “It is usually a different note than what is played and contains overtones that cannot be controlled by the tuning process” (Copeland, Personal Interview).

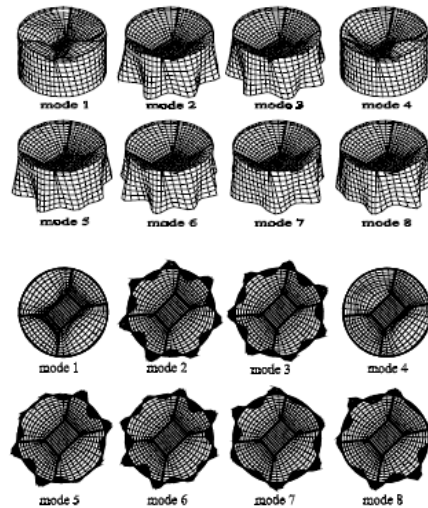


Fig. 3. Screenshot of finite element method done on Tenor Bass pan

Source; Gay, Derek. “Conventional Tenor Bass Mode Shapes, Model #1.” *Finite Element Modelling of Steelpan Acoustics*, p. 8.

The finite element modelling which Derek Gay did on the Tenor Bass and Six Bass pans show how the shell and skirt of the steelpan are affected by excitation of the notes. The modelling also showed the vibrational frequency of the skirt, which, in some cases, was a few cents¹⁵ different from the tuned notes of the instrument; this caused modulation of the fundamental note. “The modal analyses of the shells investigated demonstrate that...the vibratory modes of the composite shell surface are associated with frequencies which are typically ‘non-musical’ ... these are sufficiently close to the musical note frequency to invoke the undesirable effects of coupling” (Gay 18). This modulation affects the sound of the

¹⁵ One cent is the interval which is one hundredth of a half step for the equal tempered scale (Suits).

instrument when amplified. Fig. 3 shows the eight modes of vibration of an excited note on the Tenor Bass with a 260mm skirt, and how the coupling affects the shell. The activity seen in modes 2,3,5,6,7,8, causes modulation to the fundamental frequency of the excited note. In his research, Gay found a possible solution to mitigate the modulation of the skirt by the addition of a rolling hoop¹⁶ to the bottom of the skirt as can be seen in fig. 4. “The results suggest that the hoop structure is sufficiently stiff to act as a point of relative fixity...The hoop configuration therefore can act as a decoupling device or filter of the skirt vibrations from the notes in the playing surface” (Gay 18). In my interview with Professor Copeland, he mentioned that the rolling hoops acts similarly to braces in the body of acoustic guitars. “There are some rod supports attached to the front and back surfaces. These stiffen the body, reducing the occurrence and intensity of non-musical modes of vibration”.

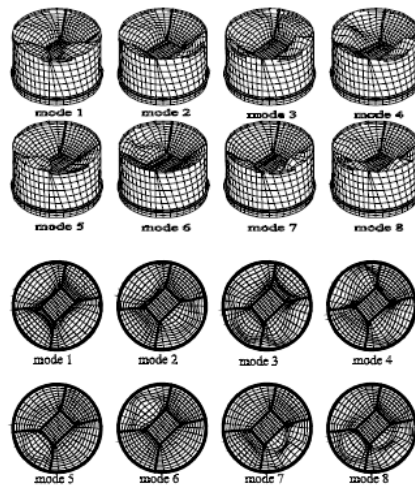


Fig. 4. Screenshot of 260mm skirt Tenor Bass with rolling hoops added

Source; Gay, Derek. “Conventional Tenor Bass Mode Shapes, Model #2.” *Finite Element Modelling of*

Steelpan Acoustics, p. 9.

¹⁶ Rolling Hoops are the hooped expansions located in the body of a drum that act as reinforcement rings (“Rolling Hoops”).

In my interviews with the tuners, they all agreed that the skirt noise does not contribute favourably to the tone of the pan. Steelpan innovator, Denzil Hernandez, created pans with wooden skirts called the “Tone Fountain” (see fig. 5). Because the skirt is made of wood, it generates very little noise in comparison to metal skirts (see appendix D). Steelpan innovator, Jimi Phillip, invented a line of skirtless pans called the “Porta Pans” (see appendix E). The Porta Pans are easier to transport and have a rich tone. There is also no additional skirt noise because there is no skirt. The skirt of the pan is replaced with a stiff ring that is 6.35mm thick, six times thicker than a normal skirt (see fig. 6 and 7).



Fig. 5. “Tone Fountain” Double Second with a wooden skirt.

Source; Hernandez, Denzil. Photograph. 18 Apr 2020. JPEG file.



Fig. 6. Screenshot of Natasha Joseph playing a Skirtless Double Second Pan

Source; Williams, Anton. Photograph. Apr 2019. PNG file.



Fig. 7. Jimi Philip and the Skirtless Tenor pan

Source; “Jim Phillip.” *Trinidad and Tobago Icons Vol. 4*, NIHERST 2017, <http://icons.niherst.gov.tt/icon/jim-philip-tt4/>, accessed 10 Apr 2020.

1.3 PROTECTIVE FINISHING

Protective finishing is an outer coat applied over the surface of the instrument to prevent corrosion. It can either be chromed, painted or powder-coated. Steelpans with chrome finishing sound brighter and louder. Notes and overtones are heard more clearly. In steelpans that are painted, the playing surface is treated with rust-resistant chemicals and polished, or spray painted. Powder-coat finishing dampens the notes and overtones of the steelpan to which it is applied, so the pan has an overall more dampened sound than one with a chrome finish. “The notes are vibrating membranes, and almost anything that is added on the notes will somehow slow down the vibration of the notes” (Peters). This is also a variable that could be explored with respect to amplification.

Regardless of which type of finish is used, a lack of maintenance can change the sound of the instrument. For a steelpan to sound at its best, the maintenance must be taken into

consideration. Excessive heat and moisture can be damaging to the steelpan. For example, when a pan is repeatedly exposed to moist, damp conditions, this causes rust. “Rust will slow down the vibration. Once the vibration is compromised, there will be a loss in volume” (Peters). Surface coating and condition is also a variable that will affect the overall sound of the steelpan.



Fig. 8. The rusted underside of a Tenor and Three Cello.

Source; Peters, Augustus. Photograph. 26 Mar 2020. JPEG file.

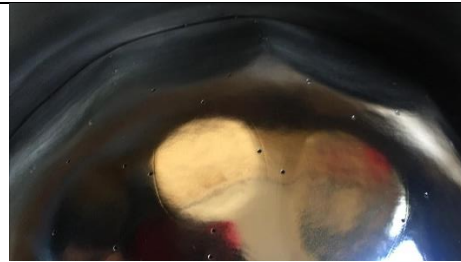


Fig. 9. The underside of a properly maintained Tenor.

Source; Joseph, Natasha. Photograph. 30 Apr 2020. JPEG file.

1.4 STICKS AND STRIKING TECHNIQUE

Pansticks also called sticks or mallets, are what players use to produce sound on the steelpan. Stick lengths and types vary depending on the preferences of the player. “The longer the stick, the louder the attack” (Kronman). The tips of the sticks are covered with rubber. Larger notes require more rubber and smaller notes require less rubber. The rubber must have a certain amount of elasticity, which helps to give the notes a smooth tone when excited and protect the notes while dampening the overtones. For the frontline pans, the rubber comes in tubes (see fig. 11) used for spearguns or surgical rubber, or strips made from rubber gloves or tourniquets that must be wrapped (see fig. 12).



Fig. 10. Speargun rubber

Source; <https://www.amazon.com/AIRSOFTPEAK-Speargun-Slingshot-Catapult-Surgical/dp/B07T62RB2L?th=1>



Fig. 11. Tourniquets for wrapping sticks

Source; Hernandez, Tiajuana. Photograph. 3 Apr 2020, JPEG file.

Generally, there are two ways to wrap sticks. The first way is tight wrapped sticks, which gives more attack and overtones are heard easier. The second way is loose. Because the range of the Double Second is so broad, players sometimes must compromise the consistency of the quality of sound they get. Some experienced players wrap their sticks tight on the inside and loose on the outside, or use different sticks depending on the repertoire.

With a well-tuned pan and proper sticks, the player still has to control the tone of the instrument. Knowing where and how to strike notes to produce both good tone and volume is very important. “Players need to spend time on their instruments to figure out where on each note gives the best tone because it is not always in the center of the note” (Peters). All the steelpan professionals that I interviewed recommended that softer striking technique produces a bigger and rounder tone, especially when the pan is amplified or recorded.



Fig. 12. Wooden and aluminum wrapped sticks

Source; Hernandez, Tijuana. Photograph. 3 Apr 2020, JPEG file.



Fig. 13. Aluminium tube rubber sticks

Source; Hernandez, Tijuana. Photograph. 3 Apr 2020, JPEG file.

1.5 TYPE OF STAND



Fig. 14. Double Seconds hanging on a stand

Source; Mc David, Shannon. Photograph. 8 Apr 2019. JPEG file.

Currently, two types of stands are used to play the instrument. The first one suspends the pans by hanging them on nylon strings. While this type of stand is common, there has not been any research done on the possibilities of other types of stands, and no consideration has been taken concerning the modes of vibration and how to control it. The second type of steelpan stand is used with Six Basses and Tenor Basses in a stage-side setting.¹⁷ These stands are flat metal and triangular and

¹⁷ Stage-side setting is a small ensemble setup of steel pans comprising ten to thirty members that play during the year at small functions such as parties, weddings, and corporate events.

are slightly raised off the ground to allow the notes to sound. A piece of rubber is attached at the apex of each corner. The rubber, in this case, has two functions: 1. to dampen the skirt noise and 2. to aid in achieving a consistently smooth sound when the notes are played. Steelpan pioneer Earl Rodney has never suspended his Double Second pans. He comes from the era when steelpan was held in the lap and played. He was friends with the late master tuner, Allan Gervais. “One day Allan was tuning a Tenor on the floor and placed some matchsticks under the pan...the tone that we got from that thing, it sounded better than when the pan was hung. That is how I ended up resting my pans on a stand” (Rodney). Earl recommends resting pans on a stand because it controls the noise of the skirt by dampening the unwanted, non-musical frequencies, without changing the timbre of the instrument. Go to <https://www.youtube.com/watch?v=qIQOKabVEHU&t=69s> to hear what Earl Rodney’s pans sound like resting down on a stand.

The skirt noise of a single side of a Double Second was tested on the stand in fig. 17. and compared to the skirt of a Double Second on a hanging stand (see fig. 18.). A Real Time Analyzer¹⁸ (RTA) application was used on a cell phone to measure the frequency and volume of the noise produced by the skirt. The results revealed that the skirt noise was reduced by almost 20 decibels (dBs) on a resting stand (see fig. 19.).

¹⁸ An RTA is a device which uses several narrow bandwidth filters connected to a display to give a visual indication of the amplitude in each frequency band (Sweetwater).



Fig. 15. Earl Rodney Double Seconds resting on a stand.

Source: <https://www.instagram.com/p/Brm8oRtASeL/>



Fig. 16. A Single Tenor version of the stand made by Jimi Phillip.

Source; Joseph, Natasha. Photograph. 7 Jan 2020. JPEG file.

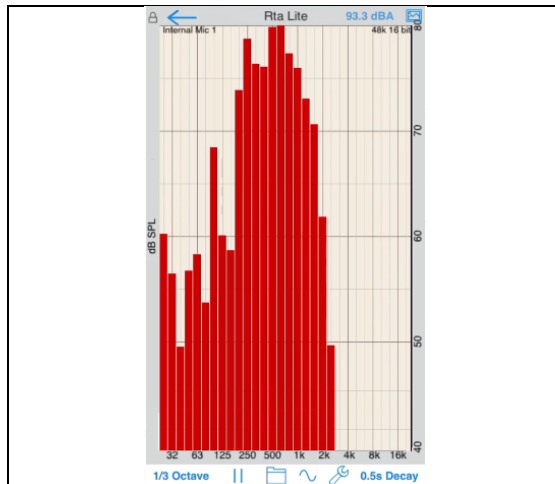


Fig. 17. Screenshot: skirt noise of suspended pan

Source; Joseph, Natasha. Photograph. 7 Jan 2020. JPEG file.

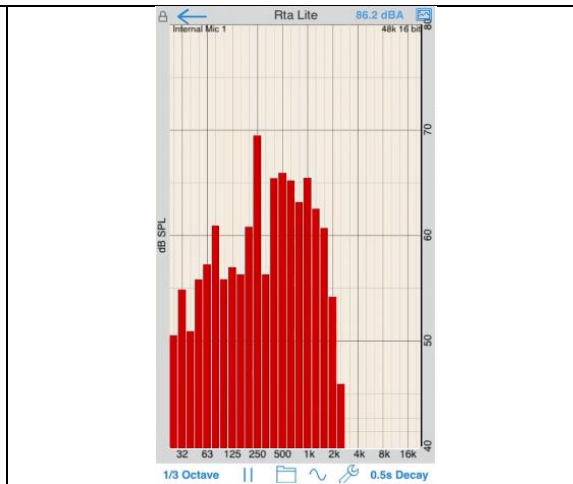


Fig. 18; Screenshot: skirt noise of resting pan

Source; Joseph, Natasha. Photograph. 7 Jan 2020. JPEG file.

This test proved that the noise was absorbed to some extent by the Jimi Phillip stand and muted some of the unwanted frequencies caused by coupling. “This is why Earl pan sounds the way it does” (Peters). Go to https://www.youtube.com/watch?v=ATCPS9U3A_s for an example of the Single Tenor resting stand used in a studio recording.

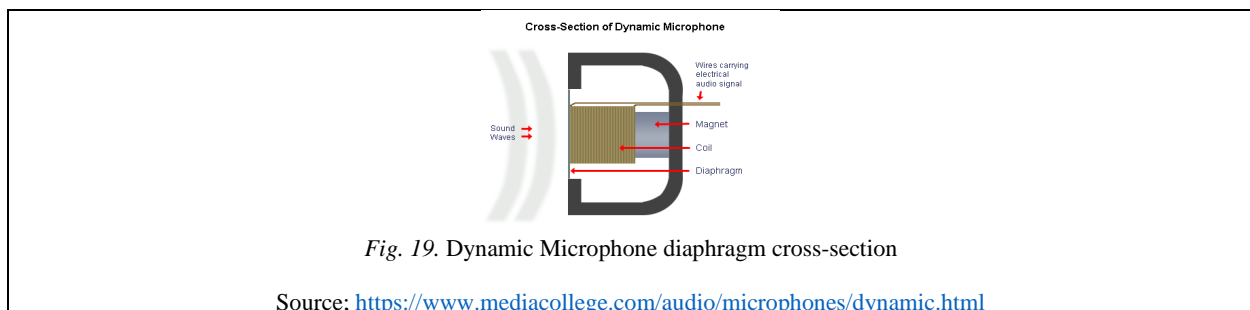
The type of stand also contributes to the sound of the steelpan when amplifying it.

CHAPTER TWO: Understanding Microphones and Their Characteristics

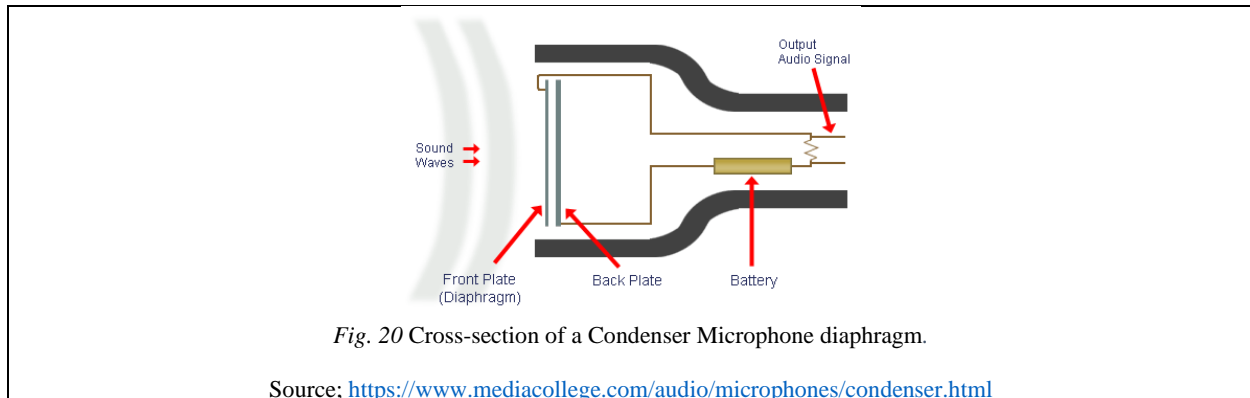
If one is interested in purchasing microphones to amplify their instrument, knowledge about the specifications and characteristics are of extreme importance. “The selection and placement of microphones is the foundation of microphone techniques” (Vear). Some characteristics of microphones are operating principle, frequency response, polar pattern or directionality, electrical output or impedance, and sound pressure level.

2.1 OPERATING PRINCIPLE

A microphone is a type of transducer that converts acoustic energy into electrical energy. The operating principle is the way that energy is transferred. Microphones have three different operating principles: - Dynamic, Ribbon, and Condenser. A dynamic microphone uses a magnet attached to a diaphragm to transfer energy (see fig. 20.). “When a magnet is moved near a coil of wire an electrical current is generated in the wire...to create the audio signal” (“How Do Microphones Work?”).



A condenser microphone, also called a capacitor, uses two steel plates, and requires phantom power to work (see fig. 21).



2.2 FREQUENCY RESPONSE

Microphones reproduce sound within a specific range. That range varies in different microphones and is called frequency response. The two types of frequency response are flat and tailored, and this is shown as a shape on a graph (see fig.22). The shape is called a response curve.

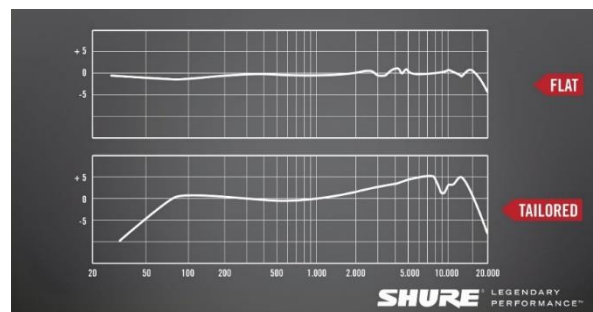


Fig. 21. Shure frequency response diagram

Source: <https://www.shure.eu/musicians/discover/educational/frequency-response>

2.3 POLAR PATTERN

The polar pattern or directionality of a microphone “refers to how the mic responds to sound coming at it from different directions” (Narell). There are several polar patterns. They are unidirectional, bidirectional, and omnidirectional. Unidirectional microphones are the most

common. They have three patterns: - cardioid, super-cardioid, or hyper-cardioid. They are used a lot in live sound reinforcement to help control leakage from other instruments on stage.

Bi-directional microphones pick up sound from the front and back only. “When there are limited mics or channels available, a microphone such as the AKG 414C with a figure of eight pattern placed in the middle of the two pans a few inches off the rim is recommended” (Marcelle).

Omnidirectional microphones pick up sound from all directions or a radius of 360 degrees.






Characteristic	Omnidirectional	Cardioid	Supercardioid	Hypercardioid	Bi-directional
Polar response pattern					
Coverage angle	360°	131°	115°	105°	90°
Angle of maximum rejection	N/A	180°	126°	110°	90°
Rear rejection (relative to front)	0	25dB	12dB	6dB	0dB
Ambient sound sensitivity	100%	33%	27%	25%	33%
Distance factor	1	1.7	1.9	2	1.7

Fig. 22. Polar Pattern Diagram

Source: <https://www.shure.eu/musicians/discover/educational/microphone-directionality-polar-pattern-basics>

2.4 IMPEDANCE

Impedance in microphones relates to the output of electrical energy and is measured in ohms. Microphones tend to have low impedance levels; usually less than 200 ohms. Low levels are essential when microphone cables must run for long distances. For persons who plan to have their own sound system to perform at weddings and small functions, the input or load impedance of the speaker or mixer must be at least five times higher than the microphone output impedance.

If the load impedance of the mixer or speaker is lower than the microphone, the sound will be distorted.

2.5 SOUND PRESSURE LEVEL

Sound Pressure level (SPL) refers to the maximum amount of volume a microphone can handle before it distorts. Generally, dynamic microphones can handle sound pressure levels up to 150-160 decibels (dBs). Condenser and ribbon microphones have a lower sound pressure level. Most steelpans have a maximum decibel output level ranging between 96dBs to 120dBs.

Understanding how microphones work informs the choices of steelpan professionals when amplifying their instrument.

CHAPTER THREE: Microphone Techniques

All microphones capture sound, but not all microphones are the same. They each have features that would work better than another in specific applications. The selection and placement of a microphone depends on the size of the acoustic space or venue, proximity to other instruments, purpose: whether live performance or recording and types of microphones available. This chapter will highlight the sound engineer's perspectives on microphone techniques as it applies to the steelpan. The Double Second comprises two pans. All the interviewees use stereo microphone placement for both live performance and recording. According to the Cambridge Dictionary, stereo refers to a way of recording or playing sound so that it is separated into two signals and produces a natural sound.

3.1 MICROPHONES OR NO?

Although this study focused on microphone techniques and sound reproduction, there are some acoustic spaces where it is best not to amplify the instrument. Some of these spaces include small venues the size of a room, and some churches. In a solo performance, there is no need for reinforcement because the closeness of the walls would make the instrument sound louder. The Ethnic Jazz Club, Jazz Studio, seats thirty guests and is approximately 20 x 14 feet in size. The Jazz Studio is one example of a place where microphones are not needed (see fig. 24 and 25). Usually, the accompanying instruments; Drums, Bass, and Keyboards, play mindfully and adjust their playing volume to maintain a good balance. "In most churches, you do not need much or any amplification. They have good acoustics that should be respected, the less amplification, the better...nothing beats the natural sound" (Copeland, Personal Interview).



Fig. 23. Ethnic Jazz Studio Performance.

Source; Nunes, Maria. Photograph. 7 Apr 2020. JPEG file.



Fig. 24. Aerial view of Ethnic Jazz Studio performance

Source; Nunes, Maria. Photograph. 7 Apr 2020. JPEG file.

3.2 PLACEMENT AND SELECTION

There are several stereo recording techniques. The ones mainly used for the Double Seconds are A-B, also called stereo, spaced, or separate pair, XY, Mid-side, and Office de Radiodiffusion Télévision Française (ORTF). A-B stereo uses two mics spaced equally, pointing in the direction of the sound source.

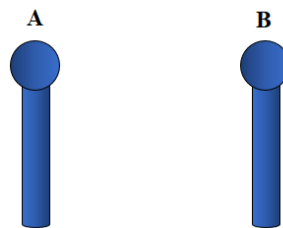


Fig. 25. Drawing of A-B microphone technique.

Source; Joseph, Natasha. Drawing. 20 Apr 2020. PNG file.

XY uses two microphones where the capsules are placed in a ninety-degree angle, one over the other.

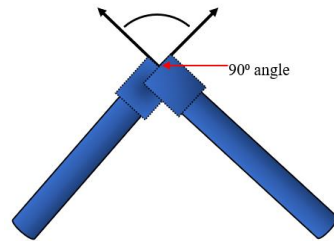


Fig. 26. Drawing of XY microphone technique

Source; Joseph, Natasha. Drawing. 20 Apr 2020. PNG file

ORTF, which is sometimes thought to be an improvement on XY, uses two microphones with the diaphragms spaced one hundred and ten degrees apart, one over the other. This captures a broader stereo image than the XY setup.

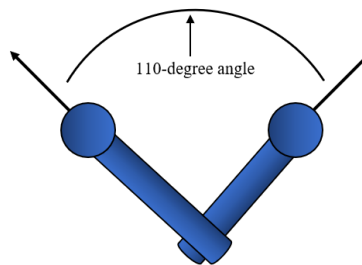


Fig. 27. Drawing of ORTF microphone technique.

Source; Joseph, Natasha. Drawing. 20 Apr 2020. PNG file

The microphone techniques mentioned above are all suspended above the instrument. Techniques involving placement below the pans will be discussed later. All of the engineers interviewed agreed that the microphones should be placed above to “eliminate the metallic overtones of the instrument” (Alvarez).

All the interviewees agreed on the use of both dynamic and condenser microphones in recording the Double Second. They also agree that the selection of microphones would depend on the tone of the instrument and “condition of the space acoustically, as well as the type of

instruments” (Imai). For example, Mark Wright stated that if the pan has a bright tone, then a large-diaphragm microphone such as the Shure SM 7B dynamic microphone would give a warmer effect. Royer 121 B and Audiotechnica Ribbon microphones would provide a smoother sound when recording. “On pans that have a more mellow tone, I will want to use a condenser microphone to capture a little more detail” (Wright).

In live performances, the polar pattern of choice for all the interviewees are cardioid or super-cardioid. This helps to eliminate leakage from other instruments on stage, especially in crowded spaces. Cardioid and super-cardioid may also be used in a studio recording where there are multiple instruments being recorded at the same time, such as an orchestra.

In my experience, XY configuration is used more, but not limited to, studio recordings. My go to is (1) a pair of large diaphragm condenser mics, cardioid or super-cardioid setting, in stereo pair, angling toward the center of the individual pans. These are for my direct sound. Then (2) I place a pair of small-diaphragm condensers in an XY position just above the head of the pannist as an overhead almost like you would for a drum kit stereo overhead. (Low Chew Tung)

Mark Wright prefers the XY technique to achieve what he calls a “beautiful stereo sound.” His philosophy is that there are two pans, so the listener should hear two things. Steelpan professional Andy Narell mentioned that XY configurations can give the listener what is called a “Phantom center” (Narell). He uses a surround sound, film scoring technique he learnt while in the studio with Francis Ford Coppola. “I put a third mic right in the center between the usual stereo pair, and the result is a smoother stereo image. It also has the effect of adding warmth without using EQ” (Narell). For more information on stereo microphone techniques, go to <https://www.teachmeaudio.com/recording/microphones/stereo-microphone-techniques/>.

3.3 DISTANCE FROM THE SOUND SOURCE

There is no established distance measure when using microphones. Experienced engineers use their knowledge of acoustics and sense of hearing to determine appropriate distances to place a microphone. Close placement would have a warmer effect and be more focused on the steelpan, and distant placement would create an airier sound of the steelpan, while also capturing the sound of the room. In live performances, the microphones are usually as close as possible to the pans to avoid leakage, because this environment tends to be noisier. Sound engineer Kino Alvarez prefers cardioid microphones and places his microphones twelve inches away from the center of the bowl. Mark Wright prefers placing microphones as close as possible, once the player is comfortable. “The player has to be comfortable to be able to move in order to execute, and the job as engineer is to capture what is executed” (Wright).

The recording studio is a controlled environment, so the distance of the microphones to pans is usually greater than in a live performance. Sometimes it takes hours before finding the right placement to achieve the desired outcome. For more information about placement, go to <https://www.teachmeaudio.com/recording/microphones/microphone-distance/>.

All the interviewees mentioned that the tone of the steelpan, in addition to the type of sticks the player uses, and the player’s striking technique, influences the type of microphones selected and where they are placed. They also identified leakage and feedback to be the major challenge in capturing and reproducing the sound of the steelpan in a live environment.

CHAPTER FOUR: Considerations

This chapter will highlight the perspectives of professional steelpan players. They have gone through extensive trial and error in both live sound reproduction and recording and have figured out what works for them in terms of microphone setup and microphone choices. All the players I have interviewed have taken control of their instrument sound by investing in their own set of microphones and accessories.

4.1 DYNAMIC MICROPHONES

The Shure SM 57 and Shure SM 58 microphones were the popular choices of all steelpan professionals and sound engineers for live and studio sound setup. “The SM57 is a good mic for the pan. You get better attack” (Copeland, Personal Interview). For more information on these microphones, go to <https://www.shure.com/en-GB/support/find-an-answer/sm57-vs-sm58>.

Kareem Thompson, Ravon Rhoden, and Khan Cordice use a pair of Shure SM 57. Curtis ‘Sleepy’ Marcelle recommended the Nady DM 70 because of its affordability. Initially designed for drums, it works well on other instruments with a high impedance and SPL.

4.2 CONDENSER MICROPHONES

Andy Narell has been a steelpan professional since the age of ten years old. He has been playing for over fifty-five years and has recorded twenty-two albums. Below are his recommendations for condenser microphones.

On stage, I like to use a pair of small-diaphragm condenser mics, but I’ll bring them down a little closer to the pans than in the studio. Occasionally a sound crew will have a pair of Neumann KM 184’s. More often, they will have something like AKG 451, Shure SM 81, or Rode NT1. I’ve recently come across some DPA mics (4011 and 4099) on gigs

and really like the sound. I also like the Shure SM 98, which is tiny and sounds good.

(Narell)

The AKG 414 C large-diaphragm condenser microphone is also a popular choice among steelpan professionals and sound engineers. The polar pattern is interchangeable, which makes it versatile. Persons can switch between Unidirectional, Omnidirectional and Bidirectional.

4.3 ABOVE OR BELOW

Most players prefer to have their microphones placed above the pans. However, at times it may be more practical to put a microphone below. Sherwin Thwaites places two Shure SM58 microphones underneath for indoor settings such as a club, or when there is a lot of wind outdoors. In the recording studio, he uses a combination of AKG C414 above to capture both the top radiating notes and room ambiance and a Neuman U47 below to capture notes that radiate below. Khuent Rose and Khan Cordice use similar above and below placement.

Sound engineer and steelpan professional, Kyle Noel had some recommendations for fellow pannists. He suggested that players first need to understand the limitation of their instrument and the limits of the technology they are aspiring to use. He believes that players should practise and experiment with their microphones, speakers, and signal processors¹⁹ to find their personal tone. By doing that, players will become confident in their unique sound and be able to articulate choices in a more informed way to a sound engineer. In a live performance setup, if the steelpan is the lead or feature instrument, Kyle suggests that the steelpan should be set up and sound checked first, and all other instruments mixed under it. He rests his pan on a Jimi Phillip stand because it naturally controls the unwanted frequencies of skirt noise.

¹⁹ A signal processor is a device that adds effects such as reverb, delay, echo etc.

Augustus Peters mentioned that a pan must be specially tuned to be able to rest on a stand. For example, if a pan is tuned in the hanging or suspended position, the vibration of the notes would be dependent on the skirt. When a pan tuned in this way rests on a stand, it would sound “corky” or “boxy.” However, if the pan is tuned by resting on something like a car tyre, or as in Allan Gervais’ case, a few matchsticks, then the notes will not be dependent on the skirt. Pans tuned in that way can be either rested or suspended.

4.4 CONTROLLING YOUR SOUND

Performers with a little technical knowledge opt to include a small four or eight-channel mixing board to their setup. This addition allows the player full control of the tone, volume of the steel pans, and placement of the microphones.

Sherwin Thwaites, Khuent Rose, Kareem Thompson, Kyle Noel, Jonathan Scales and Curtis Marcelle control the output volume and effects of their steel pans by using a small mixing board on stage. “Usually, I would do my own mix with a portable mixer and send the Auxiliary (Aux) output to the main mix²⁰” (Marcelle).

In my interview with Professor Copeland, he recommended using a 12-inch, guitar amplifier with one speaker on stage. “The guitar amplifier is designed to cover a wide range of frequencies and the notes of the Double Seconds fits within that range” (Copeland, Personal Interview). Khuent Rose uses a small mixing board, in addition to a keyboard amplifier with his Double Second. “The beauty of the keyboard amp is that it covers the full spectrum of sound” (Rose).

²⁰ The main mix is the engineer’s mixing console. This console is the central or master control for all sounds at an event.

This chapter featured the contributions of professionals who understand to some extent the acoustics of their instrument, the type of microphone that works best for them, relative microphone placement, mixing boards and speakers.

CHAPTER FIVE: EVOLUTION OF INNOVATION

5.1 THE BERTPHONE

In the late 1960s steelpan tuner, innovator, and arranger, Bertram ‘Bertie’ Marshall invented the first-ever electronic steelpan in Trinidad and Tobago, called the Bertphone. “The Bertphone was a Double Tenor. It had a pedal with felt to dampen and sustain the tones. A guitar pickup was connected to an exercise spring to make resonance, and steel rods were used as conductors.” (Slater). The elders in the steelpan fraternity still speak about the Bertphone with bittersweet awe. In 1970, a fire destroyed the research files and the only Bertphone that was ever made.

5.2 ACOUSTIC-ELECTRIC PAN

Seventeen years after the Bertphone was destroyed, in 1987, Professor Brian Copeland, in collaboration with the Carib Tokyo Steel Orchestra, tested the use of strain gauge, magnetic, and piezo transducers to produce an electric-acoustic steelpan. The design idea was like that of the electric acoustic guitar. “Just like electro-acoustic guitars, electro-acoustic pans are capable of producing audible sound with or without amplification” (Copeland, “Pickup Methods” 41). At the end of the test, the piezo pickups worked the best on all the ranges of pans “especially the bass” (Copeland, Personal Interview).



Fig. 28. Acoustic-Electric Bass pans with rolling hoops

Source; Copeland, Brian. Photograph. 1 Apr 2020. JPEG file.



Fig. 29. Acoustic-Electric Tenor pan

Source; Copeland, Brian.

Photograph. 1 Apr 2020. JPEG file.



Fig. 30. Lectrapan magnetic frame and structure on a tenor pan

Source; Copeland, Brian. "Lectrapan Owner's Manual." Lectrapan Ltd., 2001, p.2.

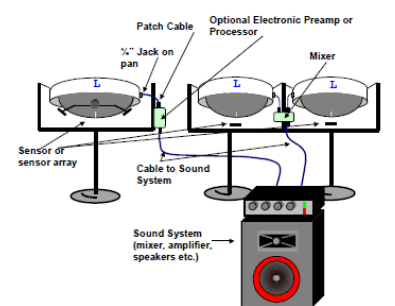


Fig. 31. Illustration of a proposed set up of Lectrapan system

Source; Copeland, Brian. "Lectrapan Owner's Manual." Lectrapan Ltd., 2001, p.4.

Seven years later the Piezo-electric transducers were successfully used by the Couva Joylanders in their Carnival performances in 1994 and 1995. In 1996, a company called Lectrapan was formed to manufacture and sell pickup systems for the steelpan (see fig.31 and 32). The company's efforts were not realised, unfortunately, due to the unavailability of funding.

5.3 ENSOUL PAN PICKUPS



Fig. 32. Screenshot of an Ensoul Pan Pickup marketed on their website.

Source;

<https://www.ensoulmusic.com/EnSoul-Pan-Pickup-250Hz-HPF-20-Inch-Lead>

Almost thirty-five years after the electric-acoustic pan, the Ensoul Pan Pickup is the newest addition on the market. It works similarly to the piezo-electric pickup and the Lectrapan system. Several steel pan professionals endorse it (Charest, Chuckaree, Salcedo, Scales, La Pierre, Rhoden, Thornton). All the endorsee interviewees recommend it for live performances only. “I can play softly, and my instrument speaks over the whole band” (Scales). It gives the steelpan the presence it needs, especially in a noisy environment, without the need to boost the volume.

However, “it does not work well in the recording environment” (Charest). Interviewees recommended adjusting the equalization settings by “taking out the high frequency and boosting the mid-range and bass a little” (Salcedo), which gives it a more natural sound.

The recommended placement of the Ensoul pan pickups for Tenor, Double Tenor, and Double Second steelpans are in the center of the belly, as shown above in figure 33.

CONCLUSION

This study focused on microphone techniques and sound reproduction of the Double Second Steelpan. The discussion highlighted the need for fundamental knowledge of the acoustic function of the instrument, in addition to an informed understanding of how microphones work in this field.

For this project, qualitative research was the method used, as opposed to field testing, and controlled environment experiments. This allowed for drawing on the expertise of several industry professionals with many years of experience working with the steelpan in both live performances and recording environments. The data from the interviews done strongly influenced the results of this study.

Interviews with tuners of the instrument identified that skirt noise contributes to feedback during performance, and this has led to some tuners experimenting with the creation of pans using different types of skirting and materials. Results from interviews with sound engineers concluded that leakage from other instruments, and feedback, were the main challenges when working with the steelpan in live performances. Both sound engineers and steelpan professionals agreed that appropriate microphone selection and placement depend on factors such as tone of the instrument, the striking technique of the player, acoustic space, proximity to other instruments, and whether it is a live performance or a recording session. They further agreed that the placement of the microphone above the instrument works best in most live and recording scenarios. They, however, recommended that placing the microphone below the pan works best in noisy areas like clubs, or outdoors where there is a lot of wind interference. The relatively new Ensoul pan pickup has been touted as a solution for live sound reproduction of the steelpan by all interviewees who use it currently.

Resulting from the findings of this thesis, some areas were identified for future research. These include scientific analysis and experimentation with different skirt materials such as wood and fibreglass; testing different types of stands; and field observation and analysis of various acoustic spaces where microphone techniques are applied to the Double Second Steelpan in live performances.

This research has provided an understanding of the current and best practices regarding sound reproduction of the Double Second Steelpan. The knowledge and techniques explored may be used to better inform those involved with the instrument and hopefully encourage each tuner, innovator, sound engineer and pannist to strive towards even greater results where sound reproduction of the instrument is concerned in the future.

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APPENDICES

APPENDIX A: ANDY NARELL'S INTERVIEW TRANSCRIPT

The following is a transcript of an email interview conducted with Andy Narell on January 17th, 2020.

1. Full Name

Andy Narell

2. Country of Birth

USA (New York City)

3. How many years as a professional musician?

55 (i was working professionally and joined the musician's union in new york when i was 10 years old).

4. How many albums recorded

I'm attaching a bio with a list of my albums, DVD, and various people that I've recorded with. There are 22 albums where I was either the leader or co-leader. I've recorded on hundreds of other records, film scores, tv shows, and commercials.

5. What type/s of mics do you use for live performance and where do you place them?

6. Do you use the same microphone setup for both live performance and recording? If the answer is no please indicate what is different about in the recording setup in terms of microphone choice and placement?

7. In our last conversation I remember you speaking about using the Neuman 184. What are the features of this mic that informed your decision to use it?

8. I also remember you saying that you control the onstage sound to ensure that your double tenor pan is present in the mix. Could you elaborate on that statement?

I'll try to answer 5- 8 together. My understanding of microphones, engineering, etc was primarily developed in recording studios, working with a diverse group of world class engineers who were invariably willing to share their knowledge. I recorded a few times in New York when I was a kid but started playing sessions seriously and paying attention to engineering after I moved to the San Francisco Bay Area in 1970. I was 16 and started working with engineers like Fred Catero (he recorded and mixed Blood Sweat and Tears, Chicago, Santana, Janis Joplin, Herbie Hancock, etc..) and Roy Halee (Simon and Garfunkel, Paul Simon, etc), Roy Segal, Phil Edwards, Steven Miller... In the 80's and 90's I did a lot of recording in Los Angeles with engineers like Allen Sides, George Massenburg, Don Murray, Rick Pekonin, as well as film scores with Dan Wallin, Shawn Murphy, Joel Moss, Bob Fernandez, Dennis Sands - all world famous engineers with thousands of credits. The film scores gave me another perspective on recording - most of the sessions I was playing with a live orchestra. I've found that for the best results in the studio, for all the different ranges of pans, I use high quality condenser or tube microphones, with small diaphragms and cardioid patterns. I should explain a few terms here.

'Cardioid' refers to how the mic responds to sound coming at it from different directions. Omnidirectional mics have the purest sound quality, but they have a 360-degree pattern, and will not focus on the instrument they're pointed at, so they have limited use in the studios, and virtually none on stage. They are mostly used to capture the sound in the room, like the sound of an orchestra in a large hall, or drums in a large room. If you want to point the mic at an instrument and have it focussed on the sound of that instrument, you will mostly use cardioid mics. Mics with a very narrow pattern are referred to as 'hyper cardioid,' and can be particularly useful onstage. I'll come back to that.

Mics are also classified by their internal elements - dynamic, ribbon, condenser (transistor), and tube mics all have different qualities. The SM 57's and 58's you see all the time on stages are dynamic mics. One of the reasons they're so prevalent is that they can stand up to rough treatment. Condenser (transistor) mics are more susceptible to injury and their diaphragms can't absorb as much sound pressure as dynamic mics. Tube mics are even more vulnerable to injury and they need their own dedicated power supplies (condenser mics get their power from the 48V output of the mixer/console, and dynamic mics don't need any outside power at all). Tube mics are almost never found in live concerts. They tend to live in closets at recording

studios and are used in controlled studio environments. When you're working with condenser and tube mics, you will need to choose between large diaphragm and small diaphragm mics. (The diaphragm is a thin membrane that responds to sound pressure. It's the key component in converting acoustic energy into electrical energy). Examples of large diaphragm condensers that you'll commonly see are AKG 414, Neumann U87, Neumann TLM series. Neumann KM 184, Neumann KM 84, AKG 451, Shure SM 81 are examples of commonly used small diaphragm mics. These mics had tube ancestors which were the dominant studio mics in the 40's and 50's. If you look at pictures of Ella Fitzgerald, Nat King Cole, and Frank Sinatra in the recording studios, you'll see large diaphragm tube mics like the Neumann U47. The Neumann M49 and AKG C12 and C12A are other classic mics of the period. Examples of small diaphragm tube mics are Neumann KM 54 and KM 64. These were all replaced by transistor mics in the 60's and 70's - mics that had better specs on paper and were much more durable and easier to maintain. However, in the 80's engineers and musicians started noticing that they often preferred the sound of the old tube mics, and a vintage mic market began to flourish. There was a limited quantity of those mics to go around, so the prices started going up like crazy, and the microphone companies responded by producing new, quieter versions of their old tube mics, like the Neumann 149 (a remake of the U49).

My favorite microphones for recording the pans are the Neumann KM 54 and KM 64 (tube microphones made in the 1950's and 60's). As I researched buying a pair for myself, I learned some interesting history about the mics. The KM 54 came out in 1953 and it has a tube which is of legendary sound quality inside, and a nickel diaphragm. Nobody knows how to make nickel diaphragms anymore, so when the diaphragms wear out, they are replaced by mylar diaphragms, which sound different and require a different type of capsule to make them sound good. Hence there's a very small number of actual working KM 54's in existence, and if the diaphragm goes the mic can't be restored to its original sound. Neumann responded to the problem by changing the shape of the capsule and producing the KM 64, which is basically a KM 54 mic with a newly designed capsule and a mylar diaphragm. I found a pair of those for sale in the 80's for \$2000 and have been using them ever since on my records. They also sound great for drum overheads, acoustic guitars, percussion, etc. almost anything you need a stereo pair for. For vocals and horns I prefer large diaphragm mics. One of the things I learned from watching how they record orchestras in LA is that the engineers mostly use cardioid small

diaphragm mics on almost everything in the percussion section, so recording pans that way was logical to them, and I had come to same conclusion doing overdubs one at a time in smaller studios.

Another thing I learned on scoring sessions was that two-channel stereo isn't the only way to go. Two channel stereo has what we call a 'phantom center,' which means that if you send the same exact signal to the left and right channels, the sound will appear to come from a point halfway between the two speakers. This is how lead vocals, bass, kick drum, and snare are usually treated and why they appear to be in the center of the mix. Engineers at LA scoring sessions routinely put an actual speaker in the center (3 channel stereo), because that's how the speakers in movie theatres are set up. (They also add two speakers in the rear - surround sound - since many theatres have that as well. I worked on the first surround sound film score - Apocalypse Now - and Francis Ford Coppola had to buy a movie theatre in San Francisco and refurbish it so he could present it in that format). The 3 channel stereo with an actual center track gave me the idea of trying to record the pans that way. I put a third mic right in the center between the usual stereo pair and the result is a smoother stereo image. It also has the effect of adding warmth without using EQ. A lot depends on the mic choice for that center mic as well. I often use this technique to record solos on albums. The center mic usually sounds best about 5 dBs lower than the stereo pair.

Engineers and musicians don't need to know a lot about the internal electronics of the equipment they're using in order to get good results, but they do need to understand the phenomenon of phase. You can learn a lot about phase by doing a couple of experiments at home. The first thing you can do is reverse the wires on the back of one of your speakers, then notice how disorienting it is to sit in front of the speakers and listen to the music. It makes me physically uncomfortable. Another thing you can do is to take a bass or kick drum track and duplicate it, send one track to the left and one to the right, and flip the phase switch on one of the tracks. Low frequencies will drop out and the volume will appear to go down instead of up when you add the two tracks together.

Whenever you have 2 mics pointed at the same instrument you need to consider the phase relationship of those two mics. If you put 2 mics in the same place and point them in exactly the same direction, the minute difference in their distance to the sound source will create some phase cancellation. The solution to this is to point the mics in different directions. When you have two

mics together but pointed 90 degrees apart from each other it's called X/Y in engineering language. It's not necessary to go that far though. When I'm in the studio I'll hang a stereo pair in the middle area of a double second at about chest height and point one towards the center of each pan. Moving the mics down will result in more low frequencies (and a warmer but less open sound) and more stereo separation. When overdubbing in the studio, or if you have good separation on a live session, you can put the mics at whatever distance sounds best to you. The same technique works with more pans - when recording triple guitars, tenor bass, and 6 bass, I still normally use 2 mics.

On stage I like to use a pair of small diaphragm condenser mics, but I'll bring them down a little closer to the pans than in the studio. Occasionally a sound crew will have a pair of Neumann KM 184's. More often they will have something like AKG 451, Shure SM 81, or Rode NT1. I've recently come across some DPA mics (4011 and 4099) on gigs and really like the sound. I also like the Shure SM 98, which is tiny and sounds good. Having said that, if the conditions are difficult (windy, or the band or the PA sound is loud on stage, etc.) I'll tell the engineer to just put up a pair of Shure SM 57's. They have a very narrow pattern, can handle wind better, and they get the job done. A lot of the problems on stage have to do with leakage, and it's important to understand how that works in a practical situation.

'Leakage' refers to everything else that the microphone hears that is NOT the instrument it's pointed at. An SM 57 pointed at a guitar amplifier will have virtually none, whereas instruments like steel pans have major leakage issues. Now imagine that the engineer is trying to get you sounding good and up in the mix. When he/she brings up the fader to turn you up, a whole bunch of other stuff that is not the pan comes up as well. The more they bring up the pan the more the overall mix gets washed out by the sound of other instruments leaking into the pan mics. The same problem exists on stage. When you put the sound of the pan in the monitors so that everybody on stage can hear it, a whole bunch of leakage comes back through the monitors, which then becomes part of the overall sound on stage, which becomes part of the leakage going back into the pan mics. It's a vicious cycle and it makes everybody sound bad in the end, and the whole band is miserable because the sound on stage is so bad and everything's feeding back (another term here - 'feedback' is a loop created by sound circulating from mics to speakers and back to the mics. the result is either a high frequency screech or a low frequency hum).

The problems normally start with drummers who play loud, bass and guitar amp levels, and monitor levels of keyboards. Once those are loud, everybody has to start pushing up their monitor levels to hear themselves and others, and the situation escalates until it's out of control. There is a solution to this problem. Play softer, keep the stage volume under control and keep the monitor levels as low as possible. I avoid playing in situations where the band plays habitually loud, but sometimes I have to appeal to the band. I try to be diplomatic. I apologize for being the problem but explain that my mics are wide open and that everything on stage is leaking into them, causing the whole cycle of misery that everyone will inevitably experience. I explain that the more their instruments leak into my mics, the worse they're all going to sound, both in the monitors and out front.

Being flexible about mic choices also helps. Some companies have hyper-cardioid versions of their mics, like the beta versions of the Shure mics (SM 57, 58, 98). These will have a little less leakage. Be prepared to move the mics in as close as possible, but make sure they're still pointed towards the center of the pans, and that you don't hit them when you're playing. Stay away from amplifiers and keep your own monitor levels as low as possible. The fastest way to create a feedback loop is to have your own monitors loud. The sound from the monitors goes straight into your mics and loops right back to the monitors.

I'm attaching a photo from a live gig where I had the small DPA mics.

Let me know if you have any further questions. Once I started answering your questions and saw it was going to take some explanation, I realised that I could turn this into an article in a series I'm writing for steel pan educators. <https://weteachpan.org> - and share this info more widely. So any feedback or questions you have might help me finish it.

all the best,

Andy



Fig. 33. Andy Narell at a performance in Japan using a pair of DPA microphones.

Source; Narell, Andy. Photograph. 17 Jan 2020. PNG file.

APPENDIX B: MICHAEL LOW CHEW TUNG'S INTERVIEW TRANSCRIPT

An email interview was done with pianist and sound engineer Michael Low Chew Tung on 31st March 2020.

1.Full Name, Qualifications, and How long in sound engineering?

Michael Low Chew Tung. Graduate of The Recording Workshop, Ohio, USA. Since 1987 so 33 years.

2. What is your position in your company?

My production company is Parlemusik, and our recording studio is WKM (We Kinda Music) Recording. I am the chief, cook, and bottle washer. I do everything from compose, arrange, perform, produce, record, mix, master, market, and distribute products since 2000.

3. What kind of mics have found work well in capturing the steelpan?

I don't have a particular brand or model of microphones for capturing steelpan. I always use what's available. That said, over the years, I've had great results with Neumann U87, AKG 414 as well as Shure SM81. However, I usually record in stereo pairs so any pair of quality large diaphragm and/or small diaphragm microphones will do.

4. With respect to the Double Seconds, what is the capture technique that you have used the most.

My go to is (1) a pair of large diaphragm condenser mics, cardioid or supercardioid setting, each one placed on the outside of each pan facing each other angling toward the center of the individual pans. These are for my direct sound. Then (2) I place a pair of small diaphragm condensers in an XY position just above the head of the pianist as an overhead almost like you would for a drum kit stereo overhead. A further mic pair can be used to record more of a room sound further away from the pans or maybe something like a PZM microphone can be employed either on the floor or even on a plexiglass, like is done with choirs sometimes.

5. Have you ever used XY, ORTF or Mid Side to record the Double Seconds, if so, were any of those techniques useful?

See description in #4

6. In your experience, what are some of the challenges faced when capturing the sound of the Double Second?

The two most important elements in capturing a great pan sound is (1) a great sounding pair of pans (2) a sensitive player with an even touch. Both are easier said than done.

7. What are some innovations that have helped to improve the capture capabilities of the Double Second?

See #6. Better and more affordable digital recording gear that mimics the operation of more expensive, vintage analog gear helps improve the overall quality of any recording including steelpans.

8. What are some considerations when working with live sound reinforcement versus recording of the Double Second?

With live sound the main concern is feedback versus amplified sound quality. I may simply use a pair of small diaphragm condensers as described in #3 (1), or a pair of dynamic mics like Shure SM57 in the same position simply to reduce the possibility of feedback and bleed from the other instrument onstage. A single large diaphragm condenser like an AKG 414 in a figure 8 setting can also do the trick when placed in between the two pans. The rest of it is effective EQing, compression and managing onstage monitor levels.

APPENDIX C: MARK WRIGHT'S INTERVIEW TRANSCRIPT



Fig. 34. Mark Wright in his Studio, Studio 3.

Source; Wright, Mark. Photograph. 3 Apr 2020. JPEG file.



Fig. 35. Mark Wright Audiotechnica endorsement photos.

Source; Wright, Mark. Photograph. 3 Apr 2020. JPEG file.

WhatsApp interview with Mark Wright on 29th April 2020.

1.Full Name, Qualifications and How long in sound engineering.

Mark Wright aka Marka

I have been a sound engineer since 1998 professionally since 1999. My qualifications span many fields. I am a certified accessor with the NTA National Training Agency and have worked with the Retraining Program. I have Co-written the CVQ the Caribbean Vocational Qualification in live sound and studio recording. I have recorded countless records with wide range of artistes spanning many genres.

2.What is name of your company and your function (eg Live sound engineer, recording engineer etc).

My Company at present is Studio3. I am both a live sound and studio recording and mix engineer.

3.What kind of mics work well in capturing the steelpan?

It really depends on the type and sonic range of the pan being recorded. It also depends on the environment the pan is being recorded in. So, a mixture or a combination of condenser and dynamic microphones are necessary.

Continued response from Mark on 3rd April 2020

So as I said earlier for each pan and the tone of that pan will influence choice of microphones and what is being recorded so if you have a Tenor pan for instance and a Tenor bore pan to record I would use two different type of microphones for that. To record a Tenor bore pan which gives you more have harmonics and higher frequencies I will want to use a warmer or duller sounding microphone, like a large diaphragm dynamic microphone like The Shure SM 7B or a ribbon microphone Royer ribbon microphone Audiotechnica ribbon microphone which will give you a smoother sound. On the traditional tenor I will want to use a condenser microphone to capture a little more detail. This is the same for Double Seconds and such.

Small format condenser microphones like the Shure SM 81's or the AKG s 63's or anything of that nature will give you a very nice tone on a Double Seconds.

For cellos and bass pans, I actually prefer to use condenser microphones in a XY configuration or a parallel stereo configuration, for the bass pans I will add you as an additional boundary microphone like a Beta 91 below the bass pan or an AKG D112 microphone which will give you a round and full tone with punch. So the condensers microphones will pick up the tone and you detail and the dynamic boundary microphones will give you the fullness and punch, a combination of those will give you my opinion the best sound.

4. With respect to the Double Seconds, what is the capture technique that you have used the most?

With Double seconds I tend to mic each pan individually with the condenser mic preferably and sometimes I would even mic the rim of the pan.

5. Have you ever used XY, ORTF or Mid Side to record the Double Seconds? If so, were any of those techniques useful?

Yes, I have used all of the listed techniques or approaches when miking the Double Second pan. Two things you must keep in mind when working with steel pans is the environment the pan is being captured in and comfort of the player. It is very important to pay attention the fluidity of the movements of the players hands this influences where are you place the microphones. This is very important because the player has to be comfortable to be able to move in order to execute

and the job is engineer is the capture what is executed so it varies from player to player what microphone technique will be used to capture that pan. Ideally, in my opinion, the best position to put a microphone is on players' chest because as the player leads over the pan most of the sound radiate upward towards the player.

6. In your experience, what are some of the challenges faced when capturing the sound of the Double Second. (e.g. skirt noise, dominant partials etc)?

In my experience I have not really had too many negative challenges in capturing the Double Second pan aside from player's technique, their choice of rubber or sticking and tonality off the pan.

7. What are some innovations that have helped to improve the capture capabilities of the Double Second?

The use of small diaphragm condenser microphones is a God send. Being able to execute a proper XY configuration above the pan with close proximity have allowed me to capture beautiful stereo images of the Double Seconds. You have two pans so you should hear two things.

8. What are some considerations when working with live sound reinforcement versus recording of the Double Second?

The things you have to consider is how is the pan being used live, is it going to be with a live complement of other pans or are they going to have live instrumentation like bass drums etc and then what role does the pan play in the show, is it a lead instrument or just a-compliment in that context you don't want have sensitive condenser mic on a loud stage capturing too much noise. Mic placement is king and for me small format close proximity that does not bother the player wins.

APPENDIX D: DENZIL HERNANDEZ TONE FOUNTAIN RESEARCH PHOTOS

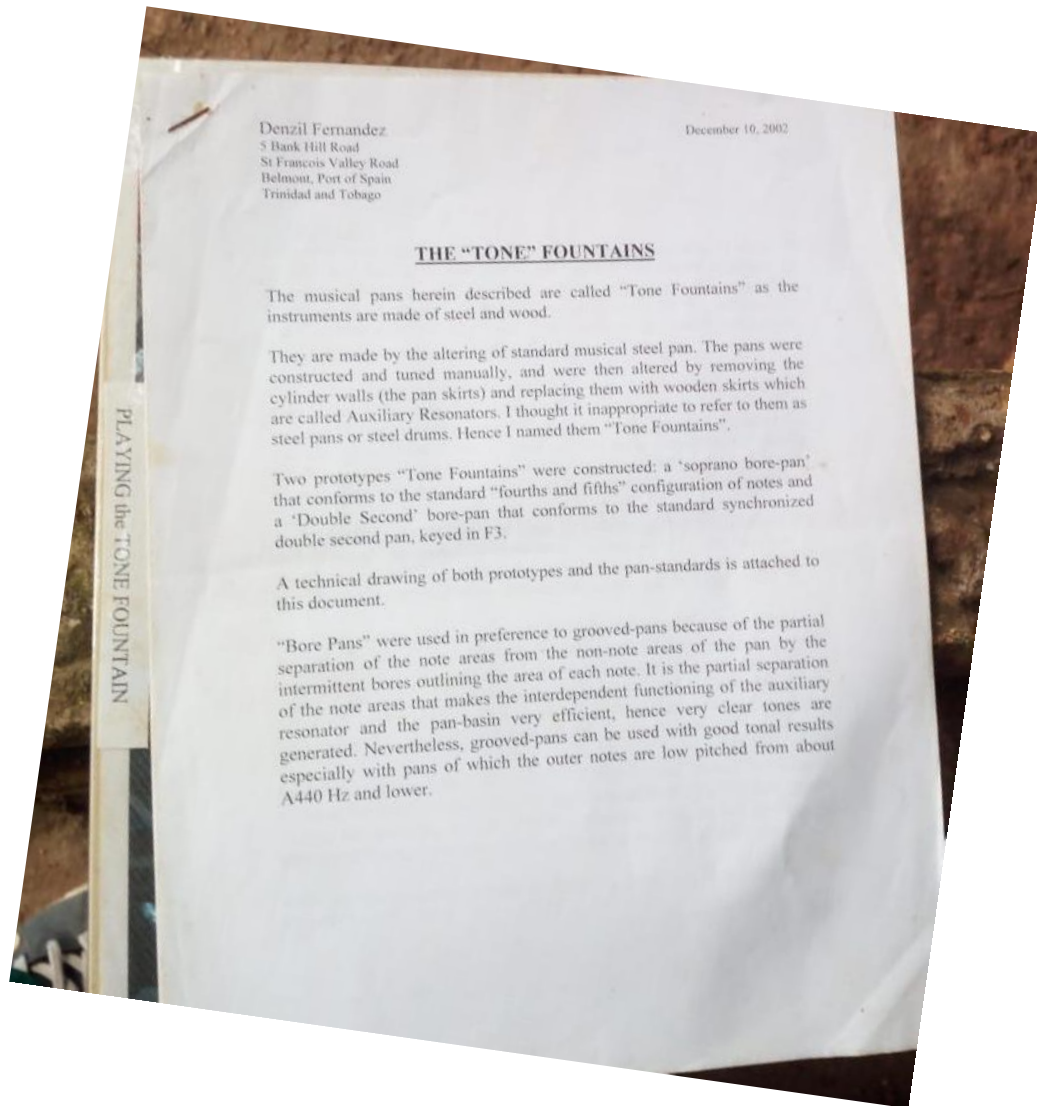


Fig. 36. Page 1 of "Tone Fountain" project notes

Source; Hernandez, Denzil. Photograph.18 Apr 2020. PNG file.

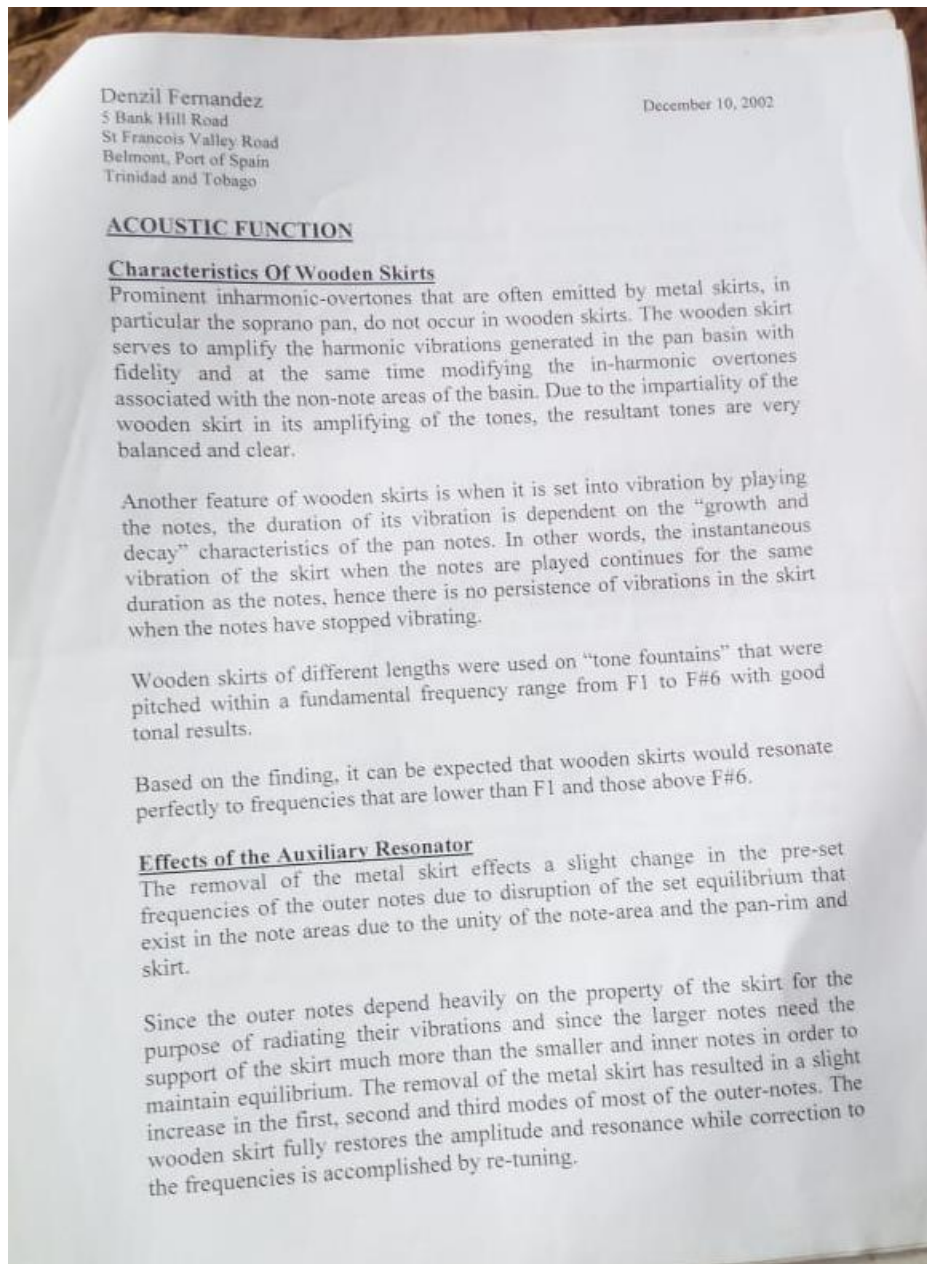


Fig. 37. Page 2 of "Tone Fountain" project notes.

Source; Hernandez, Denzil. Photograph.18 Apr 2020. PNG file.

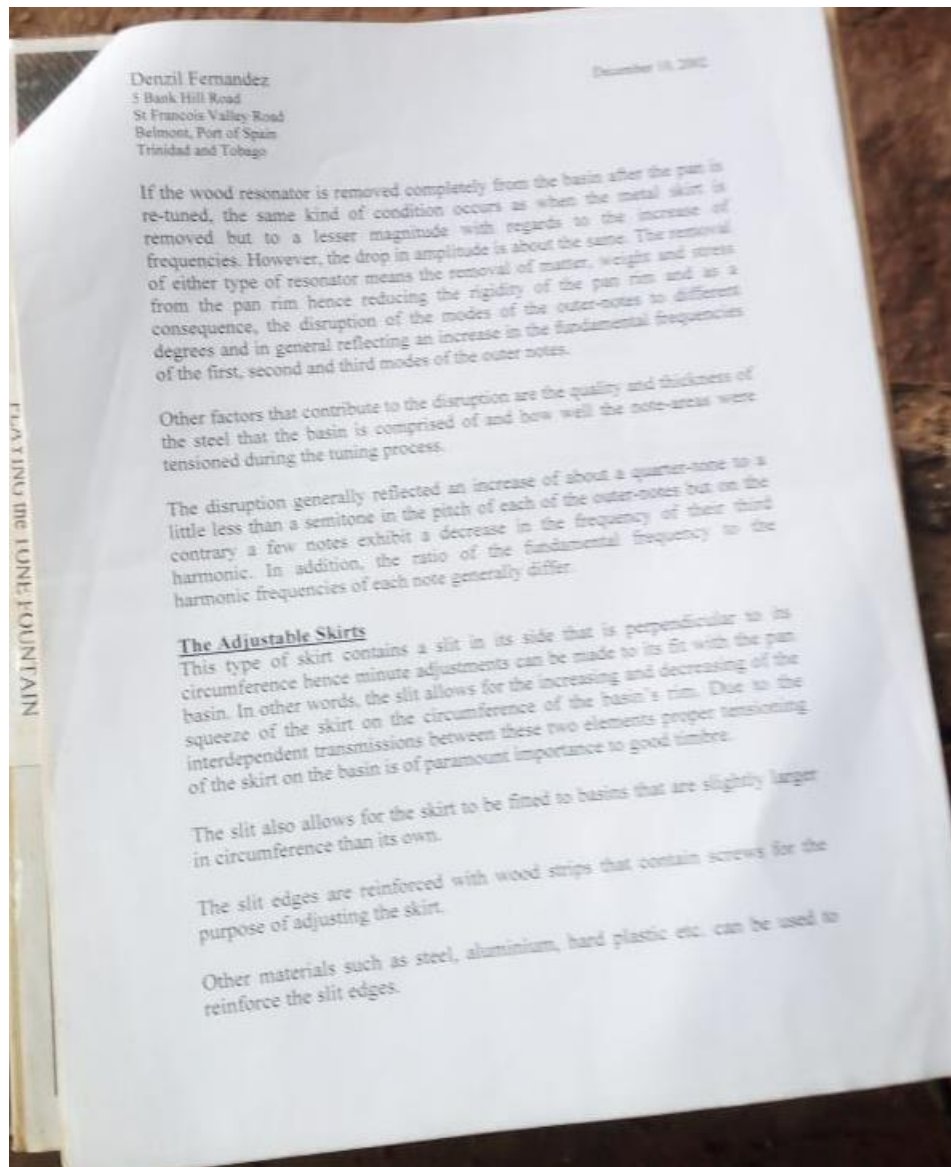


Fig. 38. Page 3 of "Tone Fountain" project notes.

Source; Hernandez, Denzil. Photograph.18 Apr 2020. PNG file.

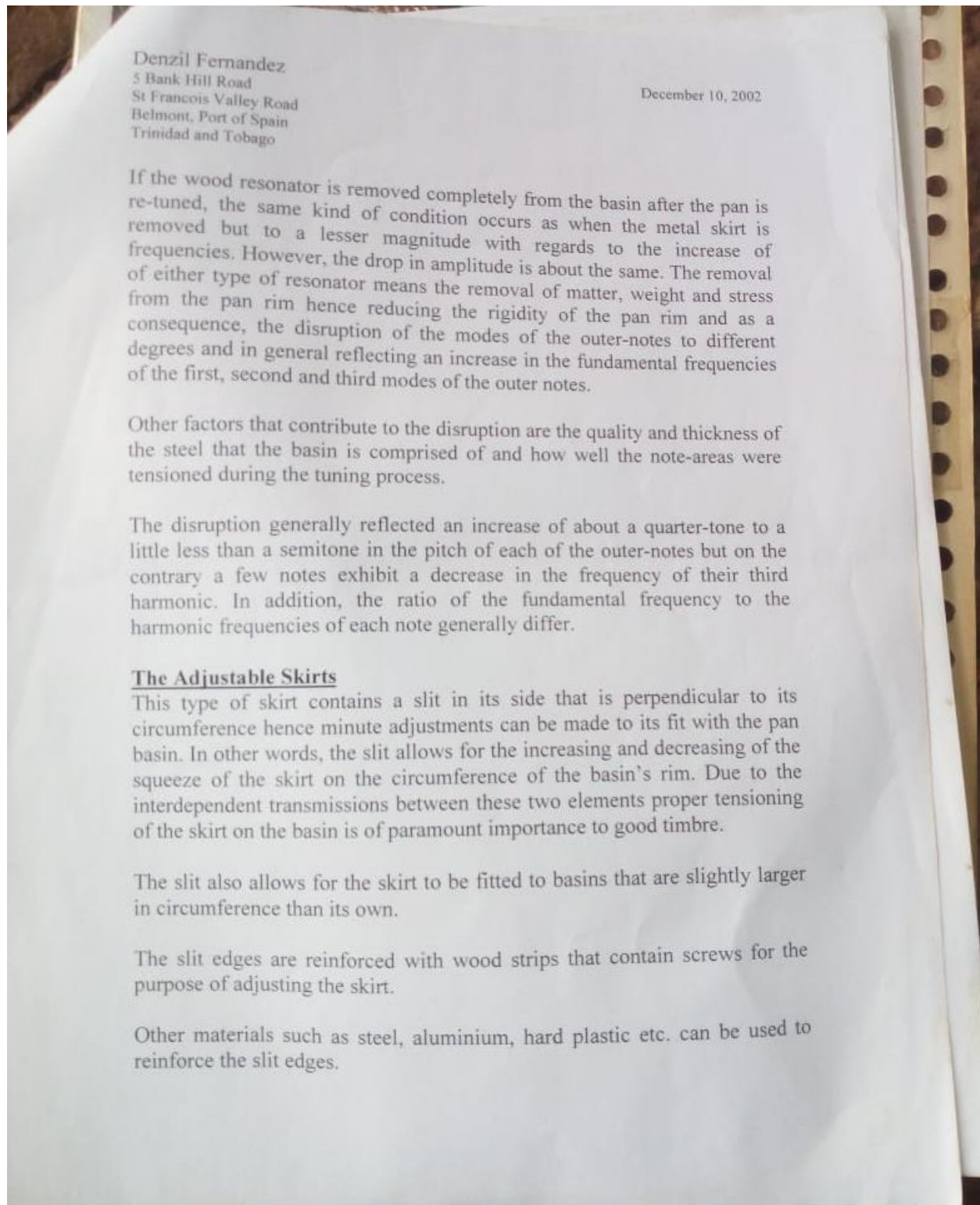


Fig. 39. Page 4 of "Tone Fountain" project notes.

Source; Hernandez, Denzil. Photograph. 18 Apr 2020. PNG file.

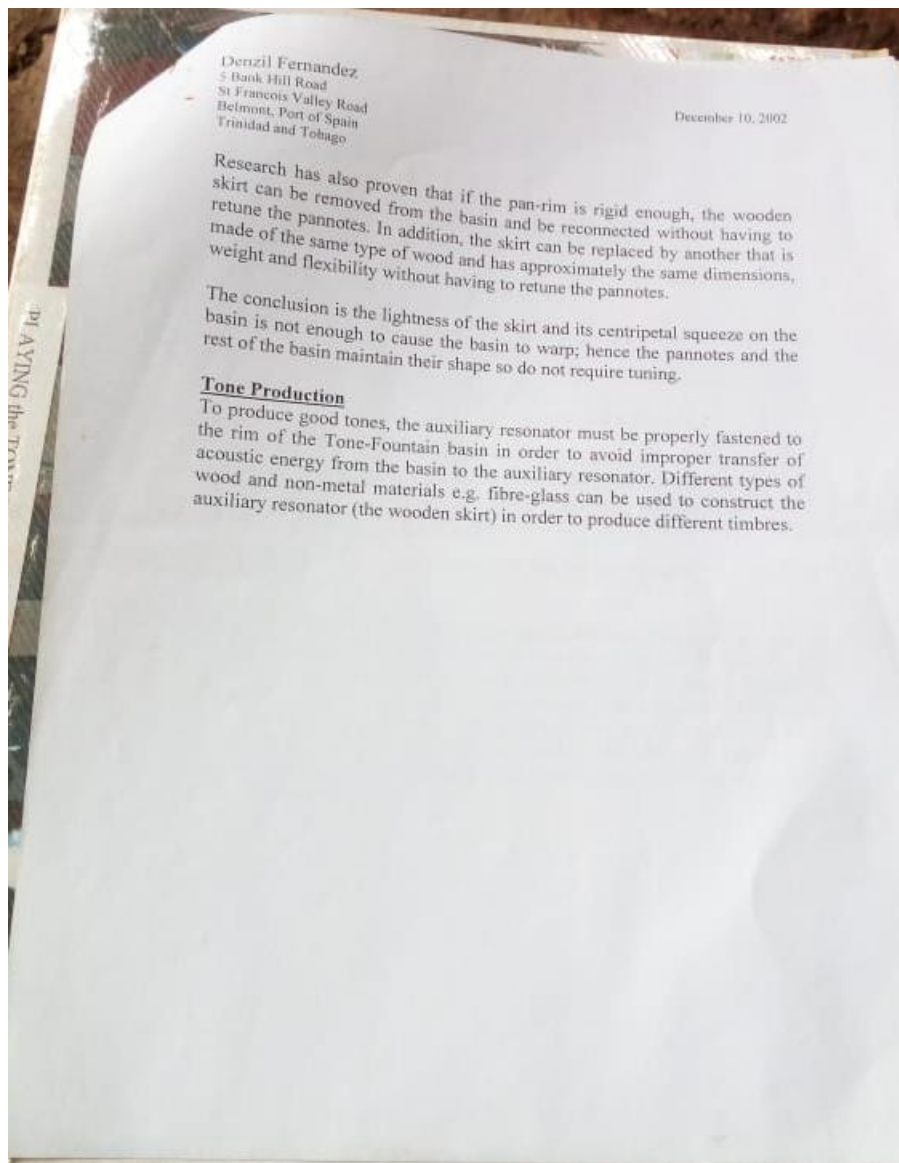


Fig. 40. Page 5 of "Tone Fountain" project notes.

Source; Hernandez, Denzil. Photograph.18 Apr 2020. PNG file.

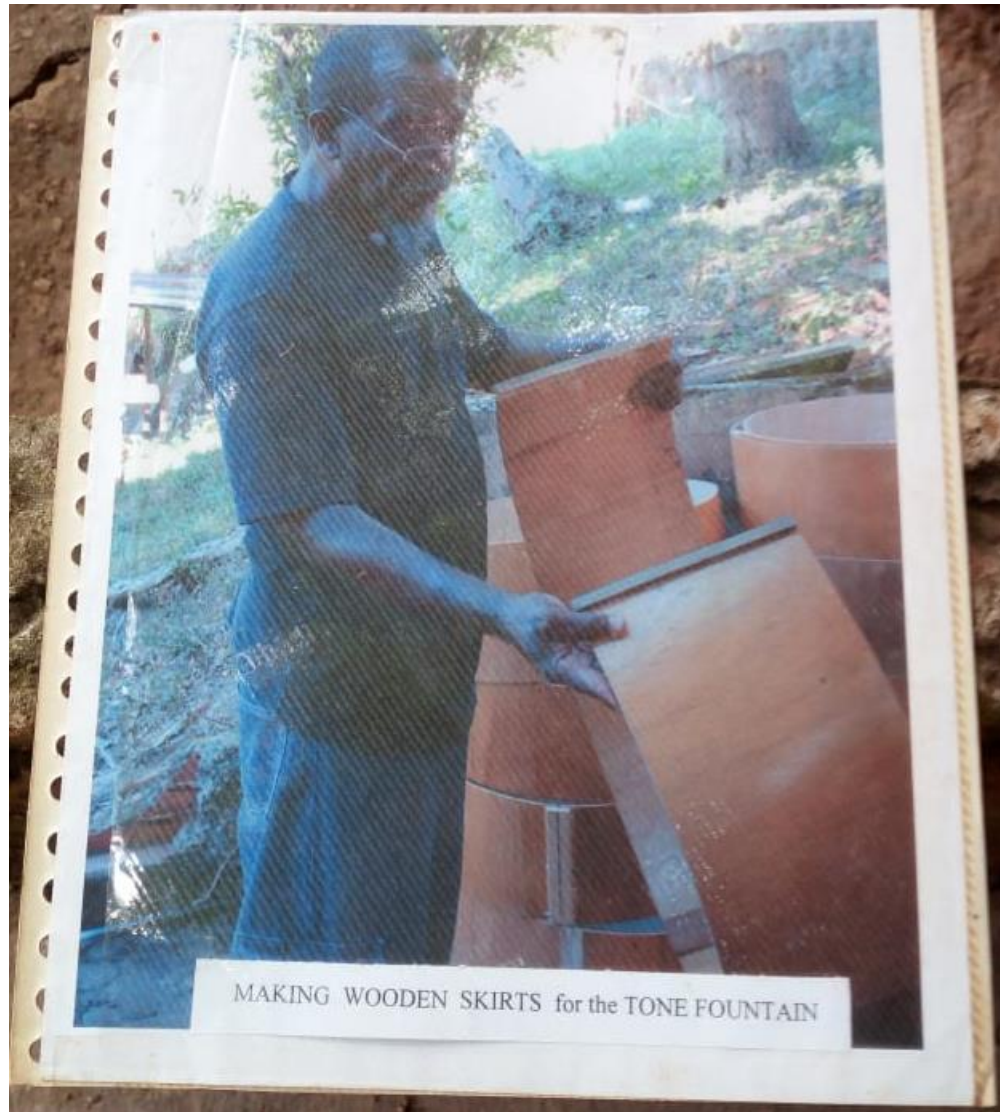


Fig. 41. "Tone Fountain" wooden skirt construction photograph.

Source; Hernandez, Denzil. Photograph. 18 Apr 2020. PNG file.

APPENDIX E: NEWSDAY ARTICLE OF PORTA PANS



Fig. 42. Photograph of Newsday article featuring Porta Pans made by steelpan tuner Jimi Phillip

Source; Copeland, Brian. Photograph. 24 Apr 2020. JPEG file.