

UNIVERSITY OF CALIFORNIA, SAN DIEGO

Melodic and Chordal Applications for Harmonics on the Double Bass:

A Study of Techniques, Chords, and Composition

A dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Musical Arts

in

Contemporary Music Performance

by

Jeffrey Charles Denson

Committee in Charge:

Professor Mark Dresser, Chair  
Professor Anthony Davis  
Professor Allan Havis  
Professor Lei Liang  
Professor Shahrokh Yadegari

2010

Copyright

Jeffrey Charles Denson, 2010

All rights reserved.

The Dissertation of Jeffrey Charles Denson is approved, and it is acceptable in quality and form for publication on microfilm and electronically: in quality and form for publication on microfilm and electronically:

---

---

---

---

---

Chair

University of California, San Diego

2010

## **DEDICATION**

I dedicate this dissertation and the completion of my D.M.A. degree to the memory of  
my grandmother, best friend, parent, and biggest supporter,  
Marjorie M. Adkins.

## TABLE OF CONTENTS

Signature Page .....	iii
Dedication.....	iv
Table of Contents .....	v
List of Figures.....	vi
Acknowledgements .....	viii
Curriculum Vitae .....	ix
Abstract of Dissertation.....	xvii
Introduction .....	1
Harmonic Series .....	11
Just Intonation .....	14
Examples of Harmonic Usage in Western Art Music .....	16
Examples of Influential Recorded Works of Improvisers' Use of Harmonics .....	26
Harmonic Generative Practices .....	32
Artificial Harmonic Exercises .....	42
Harmonic Chord Generative Practices .....	56
Scales .....	61
Chord Charts.....	62
Pieces .....	65
Concluding Thoughts .....	71
Bibliography .....	74

## LIST OF FIGURES

Figure 1.....	2
Figure 2.....	3
Figure 3.....	3
Figure 4.....	13
Figure 5.....	17
Figure 6.....	17
Figure 7.....	18
Figure 8.....	19
Figure 9.....	19
Figure 10.....	20
Figure 11.....	20
Figure 12.....	21
Figure 13.....	21
Figure 14.....	22
Pieces 15.....	23
Figure 16.....	24
Figure 17.....	25
Figure 18.....	25
Figure 19.....	34
Figure 20.....	37
Figure 21.....	41

Figure 22.....	43
Figure 23.....	44-46
Figure 24.....	47-48
Figure 25.....	49-54
Figure 26.....	55
Figure 27.....	56
Figure 28.....	57
Figure 29.....	59
Figure 30.....	60
Figure 31.....	61
Figure 32.....	62
Figure 33.....	63

## ACKNOWLEDGMENTS

I would like to take this opportunity to thank all of the people who have been so supportive of me with my work throughout this journey. I have been very fortunate in my life to be surrounded by really wonderful people, and I owe a great deal to any success that I have, and will attain, to them. Without the council, support, constructive criticism, and encouragement that I received from my chair and advisor, Mark Dresser, my work at UCSD would not have been possible. His work ethic, dedication, artistry, and passion, which are all abundantly apparent in his work as both an educator and musician, have served as a constant source of inspiration to me. I truly appreciate the meetings I had with Bert Turetzky, where he offered invaluable assistance as to where to look for information and how to approach certain aspects of this dissertation. His musical legacy of recordings, writings, and pedagogy are great sources of inspiration to me. Pepe Gonzalez, my first double bass teacher and dear friend, has been an important part of my life and has been, and continues to be a role model for me in many ways! Jeff Kaiser, my friend and colleague has been a great ally throughout my graduate studies at UCSD, and his help with technological issues along the way has been indispensable. My musical family, Minsarah (Florian Weber and Ziv Ravitz), have always inspired me to be the best musician I can be and have been there for me on so many levels. Without the support and love of my family, especially my mother and father, nothing I have ever done would have been possible. Thank you!

## CURRICULUM VITAE

### EDUCATION

- 2005-2010 University of California, San Diego. Doctor of Musical Arts  
Contemporary Music Performance.  
Private study: Mark Dresser, Anthony Davis, Lei Liang.
- 2003-2005 Florida State University. Master of Music. Jazz Studies, **Magna Cum Laude**.  
Private study: Marcus Roberts, Rodney Jordan.
- 1999-2002 Berklee College of Music. Bachelor of Music. in Performance, **Cum Laude**.  
Private study: Joe Lovano, Hal Crook, John Lockwood.
- 1997-1999 Private study: Pepe Gonzalez.
- 1998 Private study: Butch Warren.

---

### TEACHING EXPERIENCE

#### Collegiate-Level:

- April 29, 2010 UCSD Lecture in Jazz History Since 1946: Freedom and Form: 1960's Miles Davis and Wayne Shorter.
- April 22, 2010 UCSD Lecture in Jazz History Since 1946: Freedom and Form: "Charles Mingus: Double Bassist, Composer and Outspoken Political Voice".
- April 21, 2010 UCSD Lecture in MUS 150 Music of Miles Davis: "Kind of Blue: Modal Jazz – Davis, Coltrane, Adderly, and Evans".
- April 20, 2010 UCSD Lecture in Jazz History Since 1946: Freedom and Form: "John Coltrane and Modal Jazz."
- May 21, 2009 UCSD Lecture in Jazz History Since 1946: Freedom and Form: "Jazz in the 1980's: Wynton Marsalis and the Young Lions."
- March 5, 2009 UCSD Lecture in Jazz Roots and Early Development (1900-1943): "Discussing 'Body and Soul' as performed by the Benny Goodman Trio and Coleman Hawkins and His Orchestra."
- May 15, 2007 UCSD Lecture in Jazz History Since 1946: Freedom and Form: "Charles Mingus' Hatian Fight Song."
- 2006-Present University of California Teacher Assistant:  
History of the Blues: An Oral Tradition (1 x)  
Jazz Roots and Early Development (1900-1943) (3 x's)  
Jazz History Since 1946: Freedom and Form (3x's)  
The Beatles (Primary Teacher of 2 sections per week)  
Jazz Cultures (Primary Teacher of 3 sections per week)  
East Asian Pop Music (Primary Teacher of 2 sections per week)
- 2005-Present University of California Studio (Primary) Teacher:  
Double Bass

Florida State University Studio (Primary) Teacher:  
 Jazz Bass  
 Improvisation  
 Florida State University (Primary) Instructor:  
 Jazz Combos  
 Jazz Bass Master Class

2005 Florida Community College Activities Association Music  
 Symposium Artist Competition Adjudicator.

**Workshops and Clinics:**

2010 Jazz Improvisation with **Lee Konitz** in Institut für Musik Osnabrück  
 (University Conservatory Music program in Osnabrück, Germany).  
 2009 Jazz Improvisation with **Lee Konitz** in Lausanne, Switzerland.  
 2008 Improvisation and Group Interaction Master Class:  
 El Capitan High School. Lakeside, CA.  
 Improvisation and Group Interaction Master Class:  
 Institut für Musik Osnabrück (University Conservatory Music  
 program in Osnabrück, Germany).  
 2007 Improvisation and Group Interaction Master Class:  
 Hochschule für Musik Dresden (University Conservatory Music  
 program in Dresden, Germany).  
 2006 Jazz History Lecturer/Performer: Amerika Haus, Cologne, Germany.  
 2003-2005 Performer and Clinician: “Jazz in the Schools”, Series of Educational  
 presentation/performances on Jazz Music in Tallahassee, FL Public  
 Schools.  
 2003-2004 Assistant Jazz Band Director: RAA Middle School, Tallahassee, FL.  
 1999 Music Instructor: voice classes and ensembles, Day Jams Music  
 Camp, Alexandria, VA.  
 1998-1999 Private Studio Teacher: bass, Mars Music Inc., Springfield, VA.  
 1996-present Private Studio Teacher: bass, independent, VA, MA, FL and CA.

---

**SELECTED PERFORMANCES**

2010 **Lee Konitz New Quartet European CD Release Tour**  
 Birdland, Neuburg, Germany  
 Blue Note, Osnabrück, Germany  
 Brodtfabrik Jazz Festival, Frankfurt, Germany  
 Kito, Bremen, Germany  
 Cave 61, Heilbronn, Germany  
**Porgy & Bess**, Vienna, Austria  
 Café Thembi, Maastricht, Netherlands  
**Sunside**, Paris, France

- Moods, Zurich, Switzerland  
Minsarah European Tour:  
Jazzschmiede, Dusseldorf, Germany  
Unterfahrt, Munich, Germany  
Jazz Club, Freiburg, Germany
- 2009 **Cascias Jazz Festival**, Portugal w/ **Lee Konitz + Minsarah**  
**The Kennedy Center, Washington DC** w/ **Lee Konitz + Minsarah**  
**Blues Alley, Washington DC** w/ **Lee Konitz + Minsarah**  
**Festival International de Jazz De Montreal** w/ **Lee Konitz + Minsarah**  
Lausanne, Switzerland w/ **Lee Konitz + Minsarah**  
**Bimhuis**, Amsterdam, Netherlands w/ **Lee Konitz + Minsarah**  
Munich, Germany, w/ **Lee Konitz + Minsarah**  
Birdland, Neuburg, Germany w/ **Lee Konitz + Minsarah**  
Kulturzentrum Gerns, Singen, Germany w/ **Lee Konitz + Minsarah**
- Village Vanguard** w/ **Lee Konitz + Minsarah**
- 2008 **Festival De Jazz De Ponta Delgada**, Azores, Portugal w/ **Lee Konitz**  
**Enjoy Jazz Festival**, Heidelberg, Germany w/ **Lee Konitz**  
**Schaffhauser Jazz Festival**, Schaffhausen, Switzerland w/ Sepiasonic  
Small's, Manhattan, NY with Minsarah  
Sepiasonic European Tour  
Bee-Flat, Bern Switzerland  
Moods in Schiffbau, Zürich Switzerland  
LaFourmi Theater, Luzern Switzerland  
Vals Switzerland  
Radialsystem V, Berlin, Germany (RBB-Mitschnitt)  
A-Trane, Berlin, Germany  
Minsarah European Tour  
**Munich Jazz Festival**, Munich, Germany  
Moods, Zurich, Switzerland  
Nuernburg Jazz Club, Nuernburg, Germany  
Jazz Club Tonne, Dresden, Germany  
Blue Note, Osnabrück, Germany  
Sauschdall, Ulm, Germany  
**Reggio Emilia Jazz Festival Italy** w/ Claudio Puntin's Sepiasonic  
**Jeff Denson DMA Recital** performing pieces by Luciano Berio, Antonio Bibalo, Hans Werner Henze, George Perle, and Astor Piazzolla with special guests Stephanie Aston and Sky Ladd at Mandeville Recital Hall UCSD
- 2007 Gravenbroch Festival of the Arts, Germany  
**Gustav Mahler Festival, Toblach, Italy**

w/ Claudio Puntin, Florian Weber, Ziv Ravitz

**Festival International de Jazz De Montreal** (Montreal Jazz Fest)

Minsarah:

Hanny San Francisco, CA

Rosalie & Alva Performance Gallery, LA, CA

**The Athenaeum Music & Arts Library** La Jolla, CA

Moody's, Truckee, CA

Musician's Union, San Francisco, CA

Minsarah East Coast Tour

2006

Minsarah European CD Release Tour:

**JVC Jazz Festival, Paris, France**

**Enjoy Jazz Festival, Heidelberg, Germany**

Live Radio Performance WDR 3, Cologne, Germany

**Cologne Jazz Festival, Cologne, Germany**

**Berlin Jazz Festival, Berlin, Germany**

Kempen, Germany

The Bunker, Beliefeld, Germany

Brotfabrik, Frankfurt, Germany

Unterfahrt, Munich, Germany

Mammoth Lakes Jazz Festival w/ The David Patrone Quartet

**Kempen Klassik Geburtstagfest**

with **Claudio Puntin**, Florian Weber, Kempen, Germany

San Diego-Cologne-Gdansk Jazz Gdansk Ratnsz Staromiejski with  
Jeff Denson, Florian Weber, Frank Wingold, Maciej Sikala, and  
special guest Margaux Kier, Gdansk, Poland

Margaux und de Bandieten, Teatr Atelier, Sopot, Poland

Minsarah East Coast USA Tour:

Tournesol, Tallahassee, FL

Snug Harbor Jazz Bistro, New Orleans, LA

Twin's Lounge, Washington DC

Snowshoe Mountain Jazz Festival, Snowshoe, WVA

Tea Lounge, Brooklyn, NY

A Year-long, monthly series of 12 Solo Double Bass Concerts at  
Portugalia in San Diego, CA

Jeff Denson **Solo Double Bass DMA Recital**, UCSD, San Diego, CA

"Grain" by Robert Wannamaker with the SONOR Contemporary  
Music Ensemble, San Diego, CA

Two Performances of **Elliot Carter's "A Mirror On Which to  
Dwell" with the Harvey Solberger Ensemble**, San Diego, CA

Jeff Denson Trio, Elixir, Manhattan, NY

2005

Clara Lofaro Group, Rockwell's, Manhattan, NY

Ziv Ravitz Trio, Bar 4, Brooklyn, NY

Minsarah Germany Tour:

The Loft, Cologne

- Klangstation, Bonn  
 Walhalla, Wiesbaden  
 \_\_\_\_\_,Meinz  
 Kustwerk, Cologne  
 Marianne Sullivan Trio, Flute, Manhattan, NY  
 Minsarah East Coast USA Tour:  
 Simon's Wine Bar, Jacksonville, FL  
 FSU Opperman Music Hall, Tallahassee, FL  
 Tournesol, Tallahassee, FL  
 J Drewsy's, Tallahassee, FL  
 Gatorz Jazz and Blues Bar, Port Charlote, FL  
 Speak Easy, Winston Salem, NC  
 Twin's Lounge, Washington DC  
 Pentangle Arts Festival, Woodstock, VT  
 Osweego Harbor Festival, Osweego, NY  
 Inga Swearingen Quartet, Monticello Opera House, Monticello, FL  
 Florida State Jazz Ensemble: featuring **Carl Allen**, Opperman Music Hall, Tallahassee, FL.
- 2004 Jackomo Gates Trio: featuring Kevin Bales, Panama City, FL.  
 The Piano Bar: performed with **Kenny Werner**, Frauenfeld, Switzerland.
- International Jazz Festival Viersen 2004: Viersen, Germany.**  
**Generations 2004 International Jazz Meeting: Jazz Festival, Frauenfeld, Switzerland.**  
 One Europe Music Festival: Maastricht, Holland.  
 Mathias Knoop Sextet: Stadgarten, Cologne, Germany.  
 Minsarah with Oliver Groenwald: Somertheater, Detmold, Germany.  
 Tour Performances Included:  
 The Loft: Cologne, Germany.  
 Concert Series: Schloss Holte, Germany.  
 Chuck Redd Trio: The Jazz Corner, Hilton Head, SC.  
 Stephanie Nakasian and Hod O'Brien Group: featuring Leon Anderson, The Jazz Corner, Hilton Head, SC.
- 2003 **Cologne Jazz Night 2003: Jazz Festival, Cologne, Germany.**  
 Minsarah Tour Performances Included:  
 The Loft: Cologne, Germany.  
 The Bunker: Bielefeld, Germany.  
 Jakobshopf: Aachen, Germany.  
 The Jazzschmiede: Dusseldorf, Germany.  
 Halle Luja-Der Kultur Culb: Kempen, Germany.  
 Odysee: Frankfurt, Germany.  
 Artheater: Cologne, Germany.  
 "Crazy for You": (pit orchestra), Tallahassee, FL.
- 2002 Berklee Bass Night Performance: Berklee Performance Center, Boston, MA.  
 Minsarah: Detmold Concert Hall, Detmold, Germany.

- Amanda Basinger Quartet: featuring **Lionel Louke** and **Kendrick Scott**, Marche Restaurant, Boston, MA.
- The Joe Lovano 21<sup>st</sup> Century Ensemble: featuring **Joe Lovano**, Berklee Performance Center, Boston, MA.
- 2001-2002 Performances with The Berklee Urban Outreach Big Band: directed by Lin Biviano, Urban High Schools in Boston Metropolitan Area and Berklee Performance Center
- 2001 Karen Parker Group: featuring **Bob Moses** and **Andre Hayward**, The Regatta Bar, Boston, MA.
- 2000 “Cab and Lena”: (musician/actor), Boston Center for the Arts – Black Box Theater, Boston, MA.
- 1998-1999 Performance with The Levine School of Music Symphony Orchestra.
- 1998-1999 Performances with The Annandale Symphony Orchestra: Annandale, VA.
- 1998 Jazz Combo Performance: featuring **Charlie Byrd**, Northern Virginia Community College Auditorium, Annandale, VA.

---

## DISCOGRAPHY

### Co-Lead, Co-Produced, and Co-Arranged:

- July 2010 “Blurring the Lines” Minsarah, **Enja Records**
- 2010 “**Lee Konitz + Minsarah: Live at the Village Vanguard**”, **Enja Records**
- 2007 “Minsarah with **Lee Konitz**”, **Enja Records**
- 2006 “Minsarah” Minsarah, **Enja Records**
- 2003 “Minsarah” Minsarah, Hubermusic.
- 2001 “Let’s Close Our Eyes”, Breathing Three.

### Co-Lead:

- 2010 “Magnolia” Ian Tordella, Circumvention Records
- 2004 “The Bill Peterson Trio”, Bill Peterson Trio, BPMusic.

### Sideman:

- 2008 “Soundless Windchimes,” Soundtrack for **Berlin Film Festival** Premiered, Chinese/Swiss Film by director Kit Hung and score composed by Claudio Puntin and Insa Rudolph
- 2005 “Reverie”, Inga Swearingen with The Bill Peterson Trio.
- 2004 “Florida State University Jazz Ensemble featuring **Carl Allen**”.  
 “The Nicholas Simmion Quintet”, featuring **Lee Konitz**.  
 “Detmold Musik Hochschule Gospel Choir”, Detmold Musik Hochschule Gospel Choir.  
 “Transfers”, The Bryan Leitch Trio.
- 2003 “Notes on the Bridge”, Mariah Picot and the Bill Peterson Trio, Blue Music.
- 2002 “Early Summer Sketch”, Bjorn Wennas Quartet, Beartones.

- 2000 “Music for Six”, Ben Adams Sextet, Brindley Music.  
 “U Street Sounds”, Sound track for the award winning, **PBS aired**, documentary directed by Greg Smalfelt and score composed by Brian Keegan, (Communicator Award for Best Music).

---

## COMPOSITION

- 2010 “Blurring the Lines” Minsarah, **Enja Records**  
 “Intersection”  
 “When I Was a Child”  
 “Magnolia” Ian Tordella, Circumvention Records  
 “Shadow Dancing”
- 2009 “Dreams” Suite for Solo Double Bass in Seven Movements  
 “Blurring the Lines” (**Enja Records**) Minsarah  
 “Intersection”  
 “When I Was a Child”  
 “An Original Re-Orchestration for Double Bass, Clarinet, and Piano of Claude Debussy’s Quartet in G Minor, Op. 10
- 2008 “An Original Re-Orchestration for Soprano and Double Bass of George Frideric Handels’s I Know that my Redeemer Liveth.”
- 2007 “Deep Lee” (**Enja Records**) **Lee Konitz and Minsarah**  
 “As the Smoke Clears”  
 “Spiders”  
 “A Sign of Things to Come” chamber piece for four double basses, two violins, and percussion.
- 2006-Present **“Webs” Chamber Opera** (Soprano, Baritone, String Quartet, Woodwind Trio, and Piano and Double Bass Soloists) The first act was premiered San Diego, CA.
- 2006 “Minsarah” (**Enja Records**)  
 “Shift”  
 “Through the Mist”  
 “Like Water”
- 2003-present My compositions from “Minsarah” have been broadcasting on WDR (West German Radio) and Deutschland Radio (National German Radio), which is aired in Germany, parts of France, Poland, Austria, Switzerland, and the Netherlands.
- 2004 “The Bill Peterson Trio”.  
 “Lullaby”  
 “Shadow Dancing”
- 2003-2004 Composed and Arranged for Florida State University Graduate Jazz Combo.
- 2003 “Minsarah” (Hubermusic Records).  
 “Scar Tissue”  
 “Let’s Close Our Eyes”  
 “Say What”
- 2001 Composed four pieces for “Let’s Close Our Eyes”.

“Scar Tissue”  
“Let’s Close Our Eys”  
“Cryin’ for Home”

---

## HONERS AND AWARDS

2007	Lower Southern California Jazz Scholarship Award
2006	Deutsch Schallplatten Kritik Prize (German Critiques Prize) for “Minsarah”
2005	Recipient, Full Scholarship/Graduate Assistantship, University of California, San Diego. Graduated Florida State University, <b>Magna Cum Laude</b> .
2004	Selected as Participant in Gerations 2004 Jazz Workshop, Frauenfeld, Switzerland.
2003	Recipient, Full Scholarship/Graduate Assistantship, Florida State University.
2002	Graduated Berklee College of Music, <b>Cum Laude</b> . Selected as a Participant in The Joe Lovano 21 <sup>st</sup> Century Ensemble Selected as a Performer for Berklee Bass Night 2002. Recipient, Outstanding Performer Award, Berklee College of Music.
2001	Recipient, Achievement Scholarship, Berklee College of Music.
1999	Recipient, World Scholarship Tour, Berklee College of Music.

---

## GRANTS

2010	University of California, San Diego Recording Grant: Solo Double Bass
2009	University of California, San Diego Travel Grant University of California, San Diego Recording Grant: “Webs”: A Chamber Opera for Soprano, Baritone, String Quartet, Woodwind Trio, and Piano and Double Bass Soloists
2008	University of California, San Diego Recording Grant: Solo Double Bass
2007	University of California, San Diego Recording Grant: Solo Double Bass

---

## ORGANIZATION MEMBER

2009	International Society of Bassists
2003	Broadcast Music, Inc.

## **ABSTRACT OF DISSERTATION**

Melodic and Chordal Applications for Harmonics on the Double Bass:

A Study of Techniques, Chords, and Composition

by

Jeffrey Charles Denson

Doctor of Musical Arts in Contemporary Music Performance

University of California, San Diego 2010

Professor Mark Dresser, Chair

This paper examines harmonics as they appear on the double bass through looking at their use in western classical and contemporary repertoire, recorded examples of improvising musicians, how they have been taught through double bass method books, and ultimately seeks to expand the possibilities for their application on the instrument. I have codified the various different types of harmonic generative

techniques possible on the instrument and in the latter part of this paper I have created etudes for the development of these techniques. The final section of the paper I have arranged two Duke Ellington jazz standards to be played using some of the techniques in the paper.

## INTRODUCTION

With the lowest frequency range, longest string length, and largest resonating chamber of any of the string instruments, the contrabass possesses the greatest potential for overtone production, and use. I will henceforth refer to overtones as harmonics and/or partials in this paper, as all three are interchangeable terms. The frequency of the double bass is from 40Hz to 200Hz. The range of the double bass is not standardized. The number of strings or whether it has a C-extension determines where the bottom of its range will lie.

Through the mid 1800's there was no globalized standard for the tuning of or even the amount of strings on the double bass, however three string basses were most prevalent at that time. The Italians tuned the bass in fourths A, D, G, while the French tuned the bass in fifths, G, D, A, and the Germans tuned with a fifth between the bottom two and a fourth between the middle and the top string: G, D, G. Circa 1845 the F.C. Franke: Method for Double Bass was published, which it prescribed the use of a four string bass tuned in fourths: E, A, D, G. Examples of composers writing notes down to a low C, two ledger lines beneath the bass clef, have existed since before the Baroque era. Re-tuning the bass to accommodate these low notes likely solved these cases where notes below low E were requested.<sup>1</sup> Another solution for how to perform these low notes that were sporadically appearing in orchestral bass parts, was the introduction of the five string double bass. Bassist Carl Otho of the Leipzig Gewandhaus Orchestra patented his design for a five string double bass in

---

<sup>1</sup> Elgar, Raymond. *More About the Double Bass*. (Sussex: Elgar, 1969) pp. 14-17

1880 that was tuned C, E, A, D, G. This instrument began to be adopted by orchestral players throughout Europe and received several important endorsements from some of the leading European double bass pedagogues: Germany's Franz Simandl, Italy's Isaia Bille, and France's Edouard Nanny. Even with these endorsements there was some apprehension surrounding the use of the five string double bass due to issues of playability and its larger size<sup>2</sup>. Paul Brun, in "A New History of the Double Bass," quotes the principle bassist of the Berlin State Opera, Max Poike as writing in 1912:

The fifth string proved to be rather hampering for the player, and the curve of the fingerboard as well as the bridge could not be made large enough to allow all five strings to vibrate in all directions without touching other strings or the (finger)board. If, for instance, a player had to take, for instance:



it was almost impossible to avoid touching the A and C strings with the bow.<sup>3</sup>

**Figure 1 (Problematic note for bowing with a 5-string double bass circ. 1912)**

Today the most common configuration is the 4-string double bass tuned in fourths: E, A, D, G (from low to high). The upper register is subject to variability as well; the average fingerboards reach their top notes somewhere between B above middle C and C #a whole-step above middle C (sounding pitch), while some basses are equipped with upper fingerboard extensions that can reach up around E flat above middle C.

Through the use of natural and artificial harmonics the range of the double bass can be dramatically expanded upward.

---

<sup>2</sup> Brun, Paul. *A New History of the Double Bass*. (Villeneuve d'Ascq: Paul Brun Productions, 2000) pp. 156-161

<sup>3</sup> Braun. p. 157.

Written Pitch

(w/ C-Extension)

(w/ Upper Extension)

Sounding Pitch

(w/ C-Extension)

(w/ Upper Extension)

**Figure 2 (Written pitch – double bass natural harmonics range)**

In his seminal book, The Contemporary Double Bass, virtuoso bassist and renowned educator, Bert Turetzky wrote:

The contrabass has an extremely wide range of natural harmonics. Whereas violin harmonics usually cover two octaves and a fifth above the string (up to the sixth partial), the contrabass can use the tenth and even eleventh partials with clarity (especially on the top three strings).<sup>4</sup>

Natural Harmonics at Written Pitch

(w/ C-Extension)

Natural Harmonics at Sounding Pitch

(w/ C-Extension)

**Figure 3 (Sounding pitch – double bass natural harmonics range)**

<sup>4</sup> Turetzky, Bertram. *The Contemporary Contrabass*. (Berkeley, CA: The University of California Press, 1989). p. 124

While I agree with Mr. Turetzky, I would like to add to this claim by stating that it is possible to use higher partials on any of the four strings to great musical effect, however more time is needed to prepare the hand position on nodes above the 11<sup>th</sup> partial, and therefore these partials are better used in extremely slow or rubato tempos. These claims are only true when applied to the use of the bow. When using pizzicato, nodes up to the 6<sup>th</sup> partial can be consistently created with clarity, while the 7<sup>th</sup> partial is risky because this is the point where pitch content becomes a definite concern. The noise-to-pitch ratio on partials higher than the 7<sup>th</sup> is too great to be effectively used for pitch content because the sound of the attack is greater than the sound of the note itself.

Arco artificial harmonics offer a greater range of flexibility than natural harmonics. Barry Green writes in his book Advanced Techniques of Double Bass Playing:

There are several advantages for using artificial harmonics instead of natural harmonics in specific instances:

1. Intonation is completely adjustable.
2. Artificial harmonics can be found on any note of a chromatic scale.
3. When playing a melody with artificial harmonics, the timbre is more even than natural harmonics of different partials.
4. Artificial harmonics are more adaptable to diatonic or melodic writing.
5. Artificial harmonics are available on all the strings.<sup>5</sup>

---

<sup>5</sup> Green, Barry. *Advanced Techniques of Double Bass Playing: Part 2*. (Cincinnati, OH: Piper, 1976). p. 177.

These attributes make artificial harmonics an invaluable tool when using harmonics in a transposable setting such as in improvisational music or jazz, or when composing in keys that require pitches outside of what is available in the harmonic series of the open strings. The fact that the intonation of these harmonics is adjustable eliminates all of the inherent problems that exist when attempting to use natural harmonics with other instruments, especially those with fixed tuning such as keyboard instruments.

Artificial harmonics are considerably more adaptable to diatonic or melodic writing than natural harmonics because all pitches are available and their tuning can be manipulated. With natural harmonics, because their availability is restricted to the notes of the harmonic series of the open strings, scale tones, which are a necessity in diatonic melodies, are not available in all keys. Another point of consideration when using natural harmonics in diatonic melodies is that there are significant differences in timbral consistency between certain partials, not to mention the discrepancies in intonation. Due to the fact that artificial harmonics are located on all the strings, there is an established understanding of the necessary fingerings for the performer because the intervallic shapes correlate to those that exist on the fingerboard when depressing the fundamentals. Another appealing facet of the availability of artificial harmonics on all the strings is that they can be used to explore different moods or characters through the in-born timbral differences of the four strings. Alfred Blatter aptly writes in his book Instrumentation and Orchestration:

The E string is very dark and somber. The tone is a little dull and foreboding. The A string has more buzz to it but is still quite ponderous and a trifle bland. The D string is much more mellow, reedy and rich. The highest string, the G, has a very rich quality and

a larger range of expressive characteristics. It is capable of producing melodious or aggressive effects with equal ease. This string can rival any string in the orchestra for expressive playing, and yet it need not be of any particular disposition. It will adapt itself to the musical requirements.<sup>6</sup>

Though Blatter's passage does not address the use of harmonics specifically, the description is still quite useful in understanding how the effect will sound on each string.

Natural and artificial harmonics on the double bass can be produced by a variety of different techniques: pizzicato and arco, including arco artificial harmonics, artificial pizzicato harmonics, harp harmonics and two-handed harp harmonics, falsetto bowing, pulled harmonics, bi-nodal and multi-nodal harmonics, and glissandi. All of these various techniques have distinctly individual timbres with differing dynamic ranges and character. Adding these techniques of overtone production to the extensive lexicon of timbral variation available through this instrument, offers yet more shades of expressivity and musical potential to the palates of composers, interpreters, and improvisers as demonstrated by the works of such composers as George Perle in his "Monody II for Solo Double Bass," Stefano Scodini's "Six Etudes for Solo Double Bass" and his epic recorded exploration, "The Voyage that Never Ends," or Mark Dresser's work with the Arcado String Trio, the Mark Dresser Trio, and his solo recordings: "Invocation", and "Unveil." I will discuss in detail a select group of notated music from the western art music tradition as well as recordings from improvisers later in this paper.

---

<sup>6</sup> Blatter, Alfred. *Instrumentation and Orchestration*. (United States: Schirmer Thomson Learning, 1997) pp. 67-68.

In this paper when I refer to “chords” in harmonics, I am referring to the simultaneous occurrence of 3 or 4 overtones, or the illusion of such an effect through raking or quickly playing individual notes and letting them sustain and ring together. This is not to be confused with the single line approach of arpeggiating, or “spelling” a chord, or to the underlying harmony or “harmonic structure” of a given piece of music.

Compared to the great number of bassists who have forged new paths of bass playing through their exceptional technical virtuosity, melodic soloing, or time feel (the later two almost exclusively pertaining to bassists of the jazz idiom), there have been considerably fewer bassists who have pioneered the frontier of the extensive utilization of harmonics in transposable tonal settings, and even fewer in the creation of chords. Some of these pioneers of note are the western classical composer/contrabass virtuosos, Domenico Draggonetti and Giovanni Bottesini, and their contemporary counterparts, François Rabbath, Bertram Turetzky, and Stefano Scodini. From the jazz and improvised music traditions bassists such as Mark Dresser, William Parker, and the revolutionary electric bassist Jaco Pastorius have brought new techniques, concepts, and/or approaches to the use of harmonics on the instrument.

There are certain acoustical realities as well as technological issues that largely account for the fact that the use of harmonics had not been explored to the same degree as traditional playing until the late twentieth century. Instrument making, string design, the advent of amplification, pick-up and microphone technology, issues of dynamics and issues of playability are all grounds for the acceleration of harmonic

use. According to Paul Brun in his book A New History of the Double Bass, the first complete set of metal strings for the double bass was developed in the 1930's.<sup>7</sup> This is one of the single most important advances in the evolution of the double bass because it made possible new levels of virtuosity never before imaginable on the instrument. Steel strings stay in tune longer, speak faster, are more durable, allow for lower action (which in turn facilitates a greater level of virtuosity), and grant access to an incomparably greater number of overtones than are attainable on the more flaccid and less responsive gut string alternative.

One of the main reasons there has been considerably more exploration done on the utilization of harmonics through the work of bassists and composers in the western classical music tradition than in jazz is simply due to the predominance of the use of the bow. Harmonics can be accessed, sustained, and used with greater dynamic control with the bow, and certain higher partials can only be accessed with the use of the bow alone. One matter at stake here is that in traditional jazz the bass plays an integral role in the rhythm section, where its primary function is to root the music in time and harmony, bridging the gap between the drums and the other harmony-based instruments. Another simple yet fundamental reason is that the general dynamic atmosphere is not conducive to the use of harmonics because of instrumentation (drums in particular) and the traditional venues - jazz clubs and bars - where there is often a considerable amount of background noise. As mentioned above, when producing harmonics through pizzicato techniques the dynamic range is significantly lower, and this considerably limits its possible applications.

---

<sup>7</sup> Braun., p. 212

In respect to the creation of arco chords in harmonics on the double bass, the curved bridge is the biggest hindrance. Another issue is the fact that the sheer size of the instrument makes it particularly difficult to combine notes in a single hand position. The curved bridge limits the bow to the possibility of playing two strings at once, therefore permitting a maximum combination of double-stops in a single stroke. When using a pizzicato technique similar to that which is used on guitar, if the hand of the bassist is large enough, it is possible to access up to 4 notes in one hand position. Aside from its dependence on the size of the bassists' hand, the main problem here is that the dynamic range and the partials that can be produced are very limited. Even with amplification, the dynamic range of some of the partials is very limited, and their usage questionable due to the noise-to-pitch ratio that I mentioned previously.

From a pedagogical point of view, there has been very little in the way of training the bassist to gain fluency with the use of harmonics. No method dedicated purely to the study of the subject, and more specifically there exist no books on the development of chords or chord voicings in harmonics on the contrabass. In western classical double bass method books, the primary focus of any instruction on the subject has been dedicated mainly to the production and use of natural harmonics, and almost exclusively in a single-line, melodic context or arpeggios. Of course, this is because the method books were intended to prepare the bassists for the ways harmonics were most commonly used in the repertoire. Three of the most frequently used double bass method books in the literature were written in the 19<sup>th</sup> century and were mainly intended to prepare a student for orchestral bass playing: F. Simandl, New Method for the Double Bass, Edouard Nanny, Complete Method for the four and

five stringed Double Bass, and Isaia Bille, New Method Vol. 1. There have been only three books published that focus on scales and chords in harmonics on the electric bass, two of which (the first two listed) are out of print: The Book on Bass Harmonics by Jack Vees, Harmonics for the Electric Bass by Adam Novick, and Bass Harmonics: New Concepts and Techniques by Dan Peer.

This paper is an attempt to create a method for the development of harmonic generative techniques, and introduce concepts for the creation of harmonic chords, as well as to list options for the creation of various scales and provide a series of solo pieces that demonstrate the various applications for their use in tonal music.

I am interested in the study of chordal and melodic applications for harmonics on the double bass for several different reasons, the first of which is driven simply by my attraction to the sound - beautiful, ethereal, breathy tones that ring out with bell-like clarity. A new level of virtuosity can be attained through the incredible leaps in register achievable through the alternation of stopped notes and harmonics that otherwise would not be physically possible on the instrument. Another interesting prospect is that it opens up the opportunity for the creation of chords on the instrument at frequencies high enough to avoid becoming too muddy. In order to generate many harmonics (especially those higher than the 4<sup>th</sup> partial) one needs to be extremely accurate with hand placement because the locations of nodal points are so small that there is an extremely low margin of error. The accuracy one gains through the mastering of consistent node location in turn improves the player's overall intonation.

## HARMONIC SERIES

We find intervals embedded in the tonal raw material which Nature has made ready for musical use, consisting of an infinite number of tones, from the deepest barely perceptible drone to the whistle that lies at the other limit of audibility. Into this inchoate tonal mass we can introduce a certain order by the use of the immutable measures of the octave and the fifth. Nature, in fact, has herself introduced this order, and put at our disposal a whole series of other intervals as well. The eye perceives in light, which has been split up by a prism a natural series of vibration frequencies. This light the sun always produces the same immutable series of colors, familiar to us in the rainbow. Now, just as light consists of graduated colors of the spectrum, so a tone consists of many partial tones. The spectrum of the world of sound is the harmonic or overtone series.<sup>8</sup>

As Hindemith so poetically states above, the harmonic series (also known as the overtone series) is the occurrence of tones as they appear in nature. All sounds are created by vibrating bodies (such as a double bass string), which when activated (struck, plucked, bowed, etc.) send out waves of vibration, or sound waves, which are then transmitted through either the air, water, or a solid material.

When we hear a musical tone, we perceive it simply as a single pitch, but our ear actually hears a “series” of pitches that together form the dominant pitch that we first perceived. Though training and analysis of the sounds, we can learn to hear some of these pitches in the series.<sup>9</sup> This dominant pitch is referred to as the fundamental. This “series” of pitches that together form the fundamental are mathematically related

---

<sup>8</sup> Hindemith, Paul. *The Craft of Musical Composition: Book I Theoretical Part*. tr. Arthur Mendel. (London: Schott & Co., Ltd., 1937.) pp. 15-16

<sup>9</sup> Levitin, Daniel J., *This is Your Brain on Music: The Science of Human Obsession*, (New York, New York: Dutton, 2006). p. 40.

to one another, and can be represented by simple ratios. If we take a string of any given length and attach it to two fixed points, we can, by stopping the string with either a bridge or a finger in its exact center, achieve two equal lengths that produce a tone one octave higher than the original string length. This can be represented by the ratio 2:1. For example, if we take the G-string of the double bass and locate its precise center, we will find the pitch G exactly one octave higher than the open string. Here in this position we find the location of the 2<sup>nd</sup> partial, the foremost harmonic available on any string. Another way of explaining this phenomenon is that the partials of a given string (or any vibrating body) are multiples of the frequency of the fundamental: if the fundamental is  $x$ , then the 2<sup>nd</sup> partial is  $2x$ , the 3<sup>rd</sup> is  $3x$ , etc. <sup>10</sup>

As we ascend higher up into the series the partials become dynamically fainter. To simplify the following explanation, the open G-string of the double bass will be used as the basis for the examples. The 3<sup>rd</sup> partial introduces a new pitch other than the octave repetition of the fundamental tone; here the pitch is one octave plus a fifth higher than the fundamental, rendering a D. The 4<sup>th</sup> partial produces yet another repetition of the fundamental pitch, this time two octaves above. The 5<sup>th</sup> introduces us to the second different pitch, a B two octaves and a major third above the fundamental. The 6<sup>th</sup> partial is a D two octaves and a fifth above the fundamental. The 7<sup>th</sup> partial introduces a pitch that is not truly available in the equal tempered system: this pitch is so “flat” that it lies somewhere between F-natural and E-natural.

---

<sup>10</sup> Dresser, Mark., “Double Bass Harmonics” The Strad (2009)

The following example demonstrates how the harmonic series appears up to the 16<sup>th</sup> partial, using the open G-string of the double bass as the fundamental pitch.

This example notates the series in sounding pitch.



Figure 4 (Harmonic series on G-string up to 16<sup>th</sup> partial)

## JUST INTONATION

The Just Intonation Network provides the following definition for just intonation on the “What is Just Intonation” page of their website.

Just intonation is any system of tuning in which all of the intervals can be represented by ratios of whole numbers, with a strongly-implied preference for the smallest numbers compatible with a given musical purpose. . . . The simple-ratio intervals upon which just intonation is based are the fundamental constituents of melody and harmony. They are what the human auditory system recognizes as consonance, if it ever has the opportunity to hear them in a musical context. Musicians around the world have recognized the significance of whole-number ratios for at least 5000 years.<sup>11</sup>

When exploring the use of natural harmonics on the double bass one must gather at least a basic understanding of just intonation. It is an unavoidable phenomenon when attempting to use them to create chords that must be addressed, as must the issues that may arise when their use is mixed with other instruments in an ensemble setting. Why are there harmonics on the bass that share the same note name, such as D (7<sup>th</sup> partial of the E string) and D (3<sup>rd</sup> partial of the G string) “out of tune” with each other? Why do some of the harmonics on the bass seem out of tune when compared to the “same” note on the piano?

In an effort to gain an understanding of the answers to these questions as well as the system of just intonation itself, it is best to have a basic comprehension of equal temperament. Equal temperament is the system of tuning used in western music that

---

<sup>11</sup> Just Intonation Network, "What is Just Intonation," <http://www.justintonation.net/>

divides the octave into twelve equal half steps. According to the Harvard Dictionary of Music, “equal temperament is usually said to have been invented by Andreas Werckmeister c. 1700.” In order to achieve this equal division of half steps a compromise had to be reached with the tuning of each interval so that they would be essentially equally out of tune. According to the Harvard Dictionary of Music:

In equal temperament no interval other than the octave is acoustically correct or pure. The deviation of the fifth (2 cents) is too small to be perceived. With the thirds, the difference is considerably greater, the well-tempered third (400 cents) being 14 cents (one-eighth semitone) larger than the pure third (386 cents).<sup>12</sup>

The harmonic series as it appears on the strings of the double bass (or any stringed instrument for that matter) is the representation of just intonation; this is how the harmonic series appears in nature. With this being said, how does it affect the double bassist? There will obviously be problems with intonation if attempting to use natural harmonics (with the exception of the “perfect” intervals) when performing with a piano unless they are adjusted using the “pulled harmonic” technique. Theoretically this technique could be applied to the use of chords, however in terms of practical application (due to the physical demands that would be required of the hand to tune a natural harmonic chord to the equal tempered intonation of the piano) the best results can be achieved with single line melodies.

---

<sup>12</sup> Harvard Dictionary of Music, “Temperament III,” pp. 835-836

## EXAMPLES OF HARMONIC USAGE IN WESTERN ART MUSIC

The music composed by the contrabass virtuosos of the 18<sup>th</sup> and 19<sup>th</sup> centuries has been the most influential source for the advancement of harmonics in tonal music. Through this rich lineage there exist several wonderful examples of harmonics being employed melodically in a traditional tonal harmonic context (tonic/dominant relation – functional harmony). According to Bert Turetzky, “*The harmonics used by contrabassists until the beginning of the twentieth century were almost exclusively natural rather than artificial. We first encounter them in concerti about 1750.*”<sup>13</sup>

One of the first major works in the contrabass repertoire to incorporate the use of harmonics was the “Concerto in E Major” by Carl Ditters von Dittersdorf (1739-1799). Though the piece is in E Major, it is written for the bass to be tuned in solo tuning (F#, B, E, A), and therefore is notated in the key of D Major; this key was chosen in order to take full advantage of the full sonorities of the open strings, facilitating the use of the natural harmonics of these open strings. There are two distinct harmonic figures used in this piece, the first of which is a horn-like fanfare melody, which appears as a canonic response to the same figure in the other strings and reoccurs four times throughout the piece.

---

<sup>13</sup> Turetzky, p. 104

The following excerpt is the first appearance of the fanfare melody, as it appears thirty-nine bars into the first movement.



Figure 5 (Dittersdorf fanfare melody in harmonics)

The second harmonic figure that is used in the piece occurs in the fourth and final movement as the penultimate event to the finale. This is an eight bar section where the bass alternates two bars of 16<sup>th</sup> note tonic triadic arpeggios followed by two bars of 16<sup>th</sup> note dominant triadic arpeggios, and then the four bars are repeated once more. Here the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> partials are used.



14

Figure 6 (Dittersdorf tonic triad arpeggios)

Domenico Dragonetti (1763–1846) is generally considered to be the first great contrabass virtuoso of the Western Classical Music tradition. He was also a composer, contributing some of the earliest works in the double bass literary tradition. His best-known work is the Concerto in A Major (still played today in concert halls around the world), an example of the “Classical” compositional style written as a means to showcase the virtuosity of the performer. Like the Dittersdorf Concerto, the Dragonetti

<sup>14</sup> Dittersdorf, Karl Ditters Von. *Concerto in E Major*. (Kirkwood, NJ: JAH Publications, 1993.)

Concerto was written for the bass to be tuned in solo tuning to take advantage of the sonorities of the open strings.

The following excerpt is from the Allegro movement of the Dragonetti Concerto in A Major. In this passage the arpeggios of G Major and D7 are used (A Major and E7 if in solo tuning), writing up to the 8<sup>th</sup> partial on the G-string and the 7<sup>th</sup> partial on the D string.



15

Figure 7 (Dragonetti – writing up to the 8<sup>th</sup> partial)

Following Dragonetti, the next great contrabass virtuoso was the Italian bassist, composer, and conductor, Giovanni Bottesini (1821-1889). As was commonplace at the time in Italy, Bottesini played a three-string double bass (tuned A, D, and G). Bottesini brought a romantic lyricism to the bass and a new level of virtuosity. Bert Turetzky writes:

[Bottesini] refined solo technique and began writing more conjunct lyrical passages in harmonics as well as the arpeggiated type of passagework, thus enlarging the scope and concept of writing in harmonics.

The following excerpt is an example of the more lyrical and “conjunct” style of writing from Bottesini’s “Fantasia: Lucia di Lammermoor.”

<sup>15</sup> Dragonetti, Domenico. *Concerto in A Major*. (New York City: International Music Company, 1963.)

Figure 8 (Bottesini's lyric style in "Fantasia: Lucia di Lammermoor")

In the 20<sup>th</sup> century the most influential literature came from composers rather than the virtuoso performer/composers of the past. In 1949, German composer, theorist, and pedagogue Paul Hindemith composed "Sonata: for Double Bass and Piano." This is of particular interest because Hindemith's use of harmonics in his Sonata is an example of the context being used to re-frame an already established tradition. Here he utilizes natural harmonics, but instead of placing them in a tonal music setting (as was the norm for all of the 18<sup>th</sup> and 19<sup>th</sup> century music) it is placed in the midst of atonality.

Figure 9 (Hindemith's atonal use of harmonics)

<sup>16</sup> Bottesini, Giovanni. *Fantasia Lucia di Lammermoor*. (Bryn Mawr: Theodore Presser, 1962.)

His next use of harmonics in the piece examines the juxtaposition of stopped notes and harmonics.

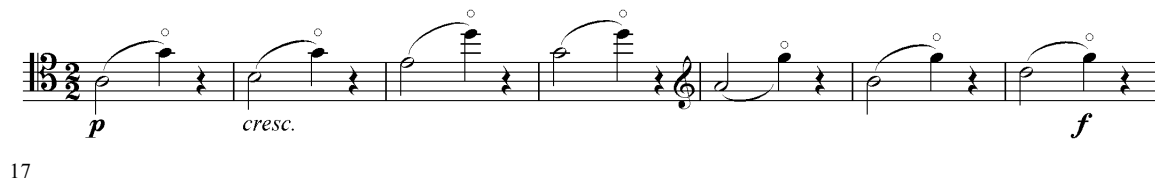


Figure 10 (Hindemith's juxtaposition of stopped notes and harmonics)

George Perle composed “Mondody II for Solo Double Bass” for Bert Turetzky in 1962. In the midst of this piece’s exploration into the vast timbral possibilities of the contrabass, there are several different uses of harmonic textures of note. The first, which is an extremely subtle example, is the use of the 3<sup>rd</sup> partial on the D string as a half-note immediately followed by another half-note on the “same pitch,” only this time using the 4<sup>th</sup> partial on the A string. The thicker string offers a darker timbre, however the difference is so subtle that it is almost indiscernible

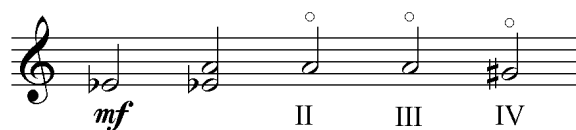


Figure 11 (Perle exploration of timbre)

<sup>17</sup> Hindemith, Paul. *Sonata for Double Bass and Piano*. (London: B. Schott's, 1950.)

The next (and immediately following) use is an example of a “pulled harmonic.”



Figure 12 (Pulled harmonic)

The subsequent use of harmonics is an interesting example of exploiting the inherent differences in tuning that appear in just intonation of the harmonic series. This texture displays a harmonic of one of the “perfect” partials (i.e. closer to the tuning of the well tempered system) and compares it to a more distantly tuned partial; in each case here it is the 7<sup>th</sup> partial (which is almost a quarter tone flat). This event is used twice in the piece, each time on a different pitch, but the second example is more dramatic due to the fact that the notes are played one right after the other, which allows the discrepancy of pitch to be fully revealed.

ex. 1



ex. 2

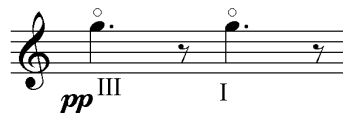


Figure 13 (Tuning discrepancies between partials)

The finale of the piece offers an excellent example of how harmonics combined with open strings can be used to perform note combinations of a wide range of separation (3 octaves in this case).



Figure 14 (Wide range separation)

In 1972, Dutch composer Ceez Luykenaar composed the aptly titled “For Harmonics Only: Double Bass Solo.” This piece is perhaps the most in-depth use of harmonics of any piece in the double bass literature. The vast majority of the piece is comprised solely of natural harmonics, with open strings used occasionally as an effect. In this piece Luykenaar deeply examines the musical possibilities that lie in the use of glissandi, vibrato, and dynamic contrast with harmonic textures, as well as the use of double, triple, and quadruple-stop chords in harmonics. The entire piece is written with a double staff, the top displaying the sounding pitch, while the bottom displays the position and string information.

---

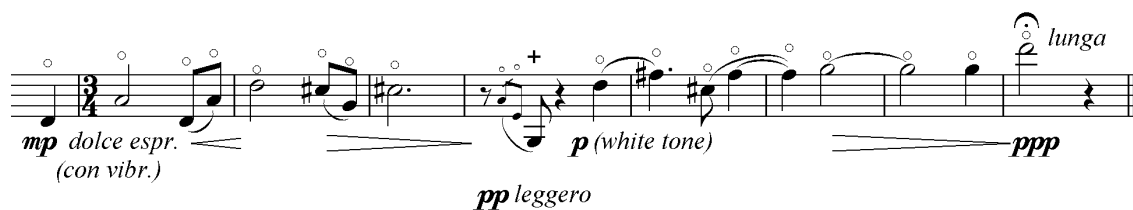
<sup>18</sup> Perle, George. *Monody II for Solo Double Bass*. (Bryn Mawr: Theodore Presser, 1962.)

19

Figure 15 (Harmonic double-stops)

In 1975 Vincent Persichetti composed his 17<sup>th</sup> “Parable” for solo instrument, “Parable for Solo Double Bass: Parable XVII.” This piece explores the extremes of timbre on the instrument with various arco and pizzicato techniques, and an expressive usage of harmonics throughout its entirety. The utilization of tempo changes and extreme dynamic shifts add a great deal of contrast to the work. The finale of this piece is the first instance of a composer explicitly directing a performer to use vibrato with harmonics. Prior to this composition the performance practice of harmonics was generally without vibrato and performed solely in the upper register on gut strings. The dominance of steel strings in the mid-twentieth century changed the harmonic potentials of the contrabass, because they were thinner than gut strings, more brilliant in harmonic content, more stable in pitch, and thus more malleable, allowing harmonics to be played successfully in the lower positions.

<sup>19</sup> Luykenaar, Ceez. *For Harmonics Only: Double Bass Solo*. (Amsterdam: Donemus, 1976.)



20

Figure 16 (Harmonic vibrato)

In Hans Werner Henze's 1977 solo for double bass, "S. Biagio 9 Agosto ore 1207: Ricordo per un contrabbasso solo," the finale of the piece displays some very advanced uses of harmonic techniques and presents a challenge to the performer as it offers no explanation as to how to realize the part. The first phrase of this section is an extremely challenging passage that incorporates the use of alternating double stops with single notes while crossing three strings at the end of the fingerboard. The only directions from the composer to the performer here add another level of complexity to the already difficult part, and perhaps puzzlement to the performer as well regarding how to attain the requested results. The note to the performer reads: "flautando dolcemente (ad. lib. tutto in armonici)" - translation: flute-like very sweetly (improvise all in harmonics). The first thing that the one notices when looking at the part is that most of the notes are not available as natural harmonics. To solve this problem one could use the natural harmonics where applicable and a technique referred to as "Italian Harmonics" for the rest of the pitches. This technique is attained by gently touching or pulling the string from the side to access the pitch, and attacked with a

<sup>20</sup> Persichetti, Vincent. *Parable XVII, op. 131*. (Bryn Mawr, PA.: Elkan-Vogel, 1975).

very light and fast bow stroke. This technique closely simulates the breathy or airy sound of natural harmonics.

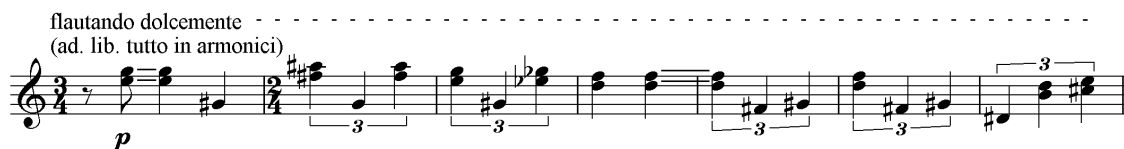


Figure 17 (“Italian” harmonics)

The finale phrase of the piece is written in an open meter where the bar lines are removed, which leaves the phrasing more open for the performer, this time, all the notes are available as natural harmonics. This phrase demonstrates the use of writing into the higher partials. To reach the final note of the piece (G# three octaves above middle C) there are several possibilities, but the two closest options which appear as natural harmonics are either the 11<sup>th</sup> partial on the D string or the 15<sup>th</sup> partial on the A string. In both cases, the note will not be “in tune” in well tempered standards (both are “flat”), and therefore (if the performer chooses to adhere to the standards of well temperament in this instance) must be adjusted by pulling the string in order to slightly raise the pitch.

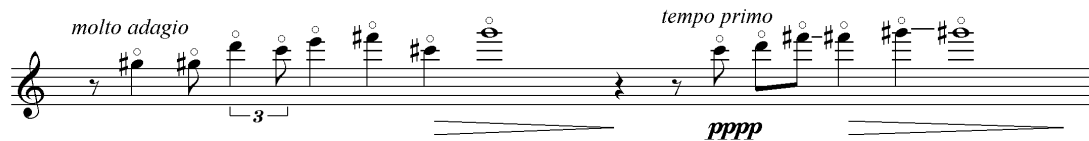


Figure 18 (use of high partials)

## EXAMPLES OF INFLUENTIAL RECORDED WORKS OF IMPROVISERS' USE OF HARMONICS

“Pluto,” from Mark Dresser’s 2005 solo bass recording, “Unveil,” (Clean Feed Records) is a step into another sonic atmosphere, one where space and the lingering resonance of other-worldly voices in the form of natural harmonics fill the air; swelling, pulsating, and then gently fading away. This musical environment is created through the use of pizzicato natural harmonics, a volume pedal, and scordatura tuning. With scordatura tuning Dresser is able to explore other harmonies with overtones that are unreachable when using the notes of the harmonic series through the standard double bass tuning. The volume pedal is in almost constant motion causing a resultant dynamic instability that gives it a distant sense of timelessness. One arco tone soars in from the seeming ether in the form of a gentle tremolo on one of the partials of the string, then shifts to a lower partial before it finally lands on a third node. This is the only occurrence of arco playing in the piece and thus stands out as a unique event against the pizzicato natural harmonic landscape.<sup>21</sup>

“For Scodinibbio” also from Mark Dresser’s “Unveil,” is an exemplary recorded example of solo polyphony. The illusion of two completely different instruments is held throughout its duration by the use constant left-handed tapping and right-handed bowed harmonic melodies with vast timbral variation through bow location. This form of polyphony is used without a specific or set harmonic structure

---

<sup>21</sup> Mark Dresser, *Unveil*, Clean Feed Records CF043CD.

or intent, as in the music of Bach; it is instead intended as a rhythmic and textural effect. With the left hand Dresser is able to create a motor-rhythmic pitched percussive sound while activating upper partials with the bow. The pitch content of the bowed harmonics is controlled through a combination of the stopped string lengths from the left-handed tapped notes and with the isolation of partials through bow location.<sup>22</sup>

“Emory,” the opening track of William Parker’s 1997 solo bass recording “Lifting the Sanctions,” (No More Records) is a tour de force of unprecedented endurance on the double bass. Parker’s ability to unleash pure energy and power is demonstrated here ten fold, with a relentless 24 minutes and 47 seconds of continuous sound. The arco texture is varied throughout while a form of extremely rapid tremolo is used as a cohesive thematic element throughout its near entirety. The piece begins with a minor theme using a normale arco technique and heavy singing vibrato. This theme functions as an undercurrent throughout the entirety of the piece, surfacing at times in subtle guises and appearing overtly in the form of an easily recognizable variation both at 13:54 for the finale at 22:52. This is a “free” improvisational piece without a harmonic structure; it is event oriented and builds energy with gestural playing and motor-rhythmic repetition. Often during the piece Parker attains a very “harmonically active” sound, meaning that through sul ponticello the overtones of the strings are activated and permeate the sound. At times specific partials are isolated and used to create very beautiful motifs, such as at 2:49-2:59, where he plays with high partial double stops juxtaposed with a tremolo of a low fundamental. Another beautiful moment is at 3:18-3:44 where he plays with single high partials, alternating

---

<sup>22</sup> Mark Dresser, *Unveil*, Clean Feed Records CF043CD.

rapidly between them and utilizing glissandi between notes of the harmonic series to create “seagull harmonics.”<sup>23</sup>

“Portrait of Tracy,” on Jaco Pastorius’s self titled solo album released by Epic Records in 1976, was a revolutionary recorded track for the electric bass, one that brought it into a new light, and redefined its role by opening up its realm of possibilities. This track utilizes a combination of natural harmonics and stopped notes to create chords on the electric bass, and alternates single lines both in harmonics and in stopped notes. This gives it two distinctly different voices, which in turn give the image of two separate instruments. Much like a piano comps for the right hand melodies with chords, bass notes or lines in the left hand, Pastorius seamlessly generates this same effect with his rapid alternation between stopped notes and harmonics.<sup>24</sup>

With an unflinching technique and flawless intonation, Renaud Garcia-Fons represents the epitome of virtuosity on the double bass. He uses a 5-string double bass with a high C string to give him the ability to reach into the range of the viola. On the track “40 Dias” from the 2005 “Arcoluz” recording on Enja Records, Garcia-Fons demonstrates a seamless transition from high register stopped note melodies into an even higher register of arco artificial harmonics from 4:53 to 5:16. This is a prime example of how arco artificial harmonics can be used to dramatically extend the range of the double bass and how it can be used in a transposable setting, unlike with natural harmonics, is not limited to the notes of the harmonic series of the open strings. His

---

<sup>23</sup> William Parker, *Lifting the Sanctions*, NoMore Records No. 6

<sup>24</sup> Jaco Pastorius, *Jaco Pastorius*, Epic Records EK33949.

melodic lines are played with crystal-like clarity and played in a register that would be otherwise impossible for the instrument. At minute marking 6:39 he glisses up to an extremely high G and holds it until 6:45 where he makes use of the new string length's harmonic series to play a major triad and resumes the G until the finale at 6:50.<sup>25</sup>

On Stefano Scodanibbio's 1998 epic 45 minute and 38 second single-track solo recording, "Voyage that Never Ends," (New Albion Records), he exhaustively explores the realm of harmonic possibilities. He uses two main generative techniques to cultivate his harmonics; for the first 16 minutes and 33 seconds he uses a ricochet bowing with a motor-rhythmic 16<sup>th</sup>-note pulse to activate the notes of the harmonic series from his open strings. Here he alternates between isolating single overtones, more than one simultaneously, and letting overtones ring out while also allowing the fundamental to ring. For this recording he uses a scorditura tuning, which he uses to create beautiful sonorities when playing double or triple stops, and also when combining harmonics with the open strings. At 10:13 a new sound is introduced: col legno pizzicato. Col legno pizzicato is a technique where the wood (or stick) of the bow is used to strike the string, which in turn creates a percussive pizzicato-like sound. While maintaining the 16<sup>th</sup>-note ricochet ostinato of the bottom open string, which slowly shifts from normale to sul ponticello, he plays melodies in sparse rhythmic phrases with the col legno pizzicato. Left-handed harp harmonics are introduced at 11:51 in the form of a raked triple stop. This is a technique of using the thumb to isolate a nodal point on the string and plucking the string with one of the fingers on the same hand. This is usually done with the right hand, however, in order

---

<sup>25</sup> Renaud Garcia-Fons Trio, *ArcoLuz*, Enja Records LC03126.

to maintain the 16<sup>th</sup>-note ricochet ostinato with the bow, the left hand is employed here. He explores the use of different triple stops over the nodal positions across the three upper strings while continuing to maintain the ricochet bowing on the bottom string. At 13:00 he utilizes a fast, flamenco guitar-like tremolo pizzicato in harp harmonics. The constant ricochet bowed ostinato is replaced by circular bowing at 16:34; here he keeps a constant sound going, but the change in texture with this new technique is quite dramatic. Circular bowing is a technique where the bow is moved in a circular or oval motion while maintaining constant contact with the string, as opposed to the standard bowing technique of moving the bow on a constant plane on the string which is perpendicular to the bridge. Much like the effect of the ricochet bowing, the circular bowing is used here to activate the overtones of the strings. While maintaining this bowing technique, he uses the left hand to play melodies with open strings. This technical feat, as well as the ricochet bowing and harp harmonics combination, are examples of great independence between right and left hands!

At 21:42 a new and quieter texture emerges when he begins to explore two-handed harp harmonic technique solely. Scodanibbio himself created this alluring and brilliantly original technique, and he reveals it in detail in his monumental transcription of the Berio Sequenza XVII for cello, re-titled Sequenza XVIIb. Here it is apparent why this technique is called two-handed “harp harmonics,” because the effect creates a delicate and beautiful sound reminiscent of a harp. Although it is a variation of the already established technique of harp harmonics, this unprecedented new version uses both hands to isolate harmonics and pluck the strings. This is quite counter-intuitive to the way the way the instrument was designed to be played! This

section builds to a rapid tremolo between 26:34 and 28:42 where he creates stunning, fast moving melodies; this section also demonstrates the highest dynamics that can be reached with this delicate technique.

The next section is yet again another stark dramatic change; here, through his mastery of bow control and bow position he is able to isolate partials while bowing an open string, creating melodies using these overtones. Scodanibbio has a virtuosic control over switching between partials in natural harmonics on single strings and the same across strings, and this is clearly demonstrated in the last 16:47 of this piece.<sup>26</sup>

---

<sup>26</sup> Stefano Scodanibbio, *Voyage that Never Ends*, New Albion Records NA101CD.

## HARMONIC GENERATIVE TECHNIQUES

### **Harmonics: Natural and Artificial**

Harmonics can be divided into two categories: natural and artificial. Natural harmonics are clear bell-like tones that can be accessed on the open strings by placing a finger over the various nodal points and plucking or bowing the string without depressing it. The harmonics or partials are more unstable and harder to produce as they go higher in the harmonic series. Natural harmonics are the most resonant type of harmonic, with a fuller sound, sustain, and greater dynamic range due to the fact they vibrate the entire string length. The one obvious limitation in the use of natural harmonics is that they are only accessible to open strings, and therefore non-transposable.

Another point of consideration is that natural harmonics fall under the system of “just intonation,” and thus all of the partials do not conform to equal temperament because various partials will clash with the tuning of instruments in equal temperament. The limitation in the tuning of natural harmonics occurs with the prime number partials above the 5<sup>th</sup> partial. These prime number partials sound out of tune when compared with their equal tempered equivalents: namely the 7<sup>th</sup> partial is flat, the 11<sup>th</sup> partial is sharp, and the 13<sup>th</sup> partial is flat. All other types of harmonics fall under the second category of artificial harmonics. What makes an artificial harmonic different than a natural harmonic is that an overtone series can be accessed on any

stopped fundamental regardless of its string length, as opposed to only those of the open strings. The ability of artificial harmonics to be generated on any stopped fundamental, beyond the limitation of the open strings, facilitates the adjusting of pitch with the left hand, and the potential to conform to the tuning of equal temperament.

### **Arco Artificial Harmonics**

The most common type of artificial harmonic is generated using the bow, and is activated when a stopped fundamental is depressed by the thumb while simultaneously a higher finger, often the second or third, lightly touches a perfect fourth above the thumb. This artificial harmonic produces a harmonic two octaves above the fundamental. Of course other artificial harmonics can be activated with interval distances greater and smaller than a perfect fourth, however this all depends on the skill level of the player, as well as the size of their hand. With these hand positions, the smaller physical distances (resulting in higher pitch) are generally not playable in distances smaller than a whole step. These harmonics are created by using the left hand to depress a note while using another finger (or the thumb, as used in artificial pizzicato harmonics) from the same hand to simulate the process of accessing partials as used in natural harmonics. When depressing a note, the scale or size of the string is altered, thus changing the harmonic series to that of the newly stopped note. This means that all of the nodal positions on the string change proportionally as well.

Arco artificial harmonics are the most flexible of all of the harmonic techniques due to the fact that they are transposable and offer the possibility for a wide dynamic range. With a “new” or “artificial” string length being created by the hand, up to seven partials from the corresponding harmonic series (depending on hand size and position on the neck) can be made available in one position.

The following figure demonstrates all the artificial harmonics that are readily accessible in one hand position, and with some practice their use can be quite dependable.



pitches in the artificial harmonic series as available as they are with natural harmonics, the practical reality is that only the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> partials are consistently available. Any partials above these harmonics tend to be unusable because the artifacts (noise component) dominate to the clarity of pitch.

To develop control over this limited dynamic range, the bassist must first ascertain what extremes of the dynamic level are possible, while insuring that the sound of the attack does not compromise the integrity of the pitch. Once the limits have been reached, the next step is to find what dynamic gradation lies between them.

### **Two-Handed Harp Harmonics**

Stefano Scodanibbio developed a special technique which functions much in the same way that Pizzicato Artificial Harmonics do, but instead of using the left hand to play stopped fundamentals, both hands are used to pluck the strings. Here, as with Pizzicato Artificial Harmonics (only this time both hands function in the same way), the thumbs divide the vibrating string lengths at the various nodal points, and plucking the strings with other fingers from the hands above the thumb (the bridge side). This technique creates a very unique sound and gives the bassist a way to create a truly polyphonic texture. As with Pizzicato Artificial Harmonics, there is an extremely limited dynamic range available with this technique and the use of microphones or amplification would most likely be necessary if used with a large ensemble, and especially with drums or percussion. Scodanibbio avoids the potential liability of this

dynamic limitation by focusing on this technique as a singular texture in the context solo performance and/or recording.

### **Harmonic Specific Flautando or Falsetto Bowing**

This artificial harmonic technique, pioneered by Mark Dresser, utilizes a similar approach as the pizzicato artificial harmonic to accessing harmonics through placing the bow directly over nodal positions on the string. The bow stroke required to produce this effect is one of speed and weightlessness. Here the bow functions like the thumb in the pizzicato artificial harmonics technique and can access the various notes of the harmonic series (of the left-handed stopped note) by choice of the corresponding node. The resultant sound is a beautiful, delicate, and airy harmonic. Due to the fact that this technique is generated by activating the harmonic by placing the bow directly over the chosen node (which is a minuscule measurement, and highly unforgiving), it is extremely important that the bow remains parallel with the bridge in order to insure constant accuracy of bow location.

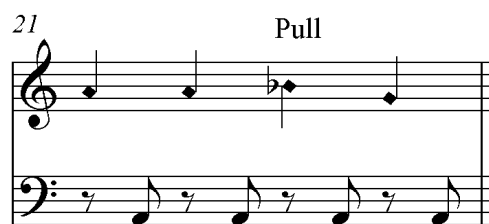
The most prominent node to use with this technique is two octaves above the stopped note, which produces the corresponding sound (two octaves above the stopped fundamental). This harmonic technique can be achieved with a great degree of success, however it takes a considerable amount of practice to master. In order to maintain the activation of the harmonics when changing pitches, the bow must move in tandem with the left hand, always staying exactly on the nodes two octaves above

the stopped fundamentals. Without staying on the precise nodal locations and maintaining a fast and even bow speed, the fundamental will be activated, which in turn will override the harmonic. The same effect is possible with the node located two octaves and a fifth above the fundamental pitch, which again produces the corresponding pitch of the nodal location. This is an even more delicate feat, and can easily be missed if any of the aforementioned considerations are not upheld.

### **Pulled Harmonics**

This technique allows the double bassist to alter the pitch of a natural harmonic by first initiating the harmonic and then “pulling” the string, either left, right, or up off the fingerboard, thereby increasing the tension on the string which in turn raises the pitch. The range in which the pitch can be adjusted depends on the amount of tension used when pulling the string. Practically speaking, however, reaching a whole step is quite a “stretch.”

The following figure is from my arrangement of Duke Ellington’s “Come Sunday”, demonstrating the use of the pulled harmonic technique in order to gain access to the E flat, which is otherwise not available as a harmonic.



**Figure 20 (Pulled harmonic in “Come Sunday”)**

### **Bi-Nodal and Multi-Nodal Harmonics**

This technique is a means by which one can artificially generate partials other than those that exist in any given left hand position by combining two or more harmonics. Though theoretically bi-nodal and/or multi-nodal harmonics can be created with any combination of partials, there is the inescapable reality of physical distance from one partial to the next as well as the performer's hand size that must be considered. One practical, yet highly evocative technique is the dividing of the string length in between a given partial and the nut. This will render a harmonic one octave above the initial partial. One important consideration here, which holds true with the playing of any partials, is that the higher the partial played, the more bow speed is needed.

### **Harmonic Glissandi**

Harmonic glissando is a technique that not only creates a beautiful and dramatic effect, but it allows for the use of pitches that otherwise are not available in the harmonic series of a double bass in standard tuning. Simply, the goal here is to activate the harmonic and then slide the pitch up and/or down with a glissando, being careful not to disturb the vibration of the string which would cause the fundamental to sound. Essentially this technique is the art of motion without motion. A great deal of control of pressure and speed from both the left and right hand are required to maintain the harmonic. The same attack is used with the left hand in creating this effect as with any harmonic technique, however more pressure and contact with the string are required when engaging the glissando motion. A consistent rate of left hand

speed is necessary to keep the harmonic engaged. There is a delicate balance that must be achieved between the speed of the left hand glissando and that of the bow. A fast bow speed is needed, and as is true with all harmonic techniques, placing the bow over nodal positions produces the most consistent results.

Due to the consistency of speed required to maintain the harmonic, bow pressure is the variant that can be used in order to control dynamics.

### **Pizzicato Harmonic Glissandi**

All of the considerations in creating this technique are the same as in the arco version, except those of the right hand. As with most pizzicato techniques, after the string has been plucked only the left hand remains in action. Due to the rapid rate of decay, if a larger interval is desired, then a faster glissando is required for the intended destination to be audible. There is one considerable difference in the sonic outcome of this technique that does not occur when the bow is used, and that is the sounding of bi-tones. Due to the fragility of the sound (and resultant low dynamic range) of this technique, the bi-tone can be heard along with the fingered pitch. When the vibration of the string is set in motion, both sides vibrate, each creating a tone that corresponds directly to the amount of string length it is given. When playing the double bass, the bridge side of the string's inherent dominance precludes the "back-side" of the string from being heard. This is due to the physical construction and design of the instrument with the strings reaching their highest point off of the body at the bridge. Vibrations travel down through its legs, and into the sound post, bouncing off the back of the body, into the resonating chamber, before exiting the F holes. Without the aid of

special pick-ups or microphone techniques - such as those pioneered by Mark Dresser - it would be very difficult to make the bi-tones audible.

The velocity of the glissando, generated by the speed at which the hand is in motion, can affect the sound of the bi-tone and fundamental pitch as well. A slow glissando will allow the sound of both the bi-tone and the fundamental to decay naturally; in the process of this decay, both sounds bleed together as they decline. A rapid glissando cause an audible increase in dynamic, especially that of the bi-tone. There is a punctuated sound where the hand stops the notes, mirroring the movement of the hand itself.

Allowing the bi-tones to ring when executing a pizzicato harmonic glissando generates a fascinating polyphonic sound. Since the vibrating string length is being shortened or lengthened (depending on whether the glissando is ascending or descending) the exact opposite is true for the other side of the string. The resultant pitch of the opposite side of the string is made audible because a natural harmonic is a multiple of the entire string length. If the pure harmonic glissando (without its resultant bi-tones) is desired then the string can be muted behind the target note with one of the remaining fingers from the left hand.

The following figure is from my arrangement of Duke Ellington's "Come Sunday", demonstrating the use of a combination of a bi-tone resulting from a pizzicato glissando and their simultaneous ringing with an open string, creating a triad in second inversion.

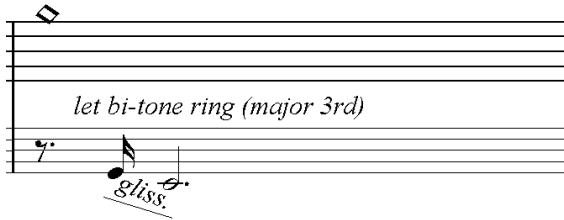


Figure 21 (Harmonic glissando w/ audible bi-tone)

## **ARTIFICIAL HARMONIC EXERCISES**

The following exercises are designed to give the bassist mastery over the various aspects of each of the techniques discussed.

The following etude was written to give the bassist the necessary skills in shifting with these hand shapes in thumb position that are essential for success with the ensuing Artificial Harmonics Exercises.

## Thumb Position: Upper Tetra Chords in Cycle of 5ths

Jeff Denson

5

9

13

17

21

Figure 22 (Preparatory thumb positions exercise)

## Artificial Harmonics Exercise 1: Arpeggios up to the 9th in a Single Hand Position

Jeff Denson

Partials 3 4 5 6 7 8 9 8 7 6 5 4

The exercise consists of five systems, each with a treble clef staff and a bass clef staff. The first system is labeled 'G or D string' and includes a dashed line with '8<sup>va</sup>' above it and a sequence of partials (3, 4, 5, 6, 7, 8, 9, 8, 7, 6, 5, 4) above the staff. The second system is labeled 'G string' and includes a dashed line with '8<sup>va</sup>' above it. The third system is labeled 'D string' and includes a dashed line with '8<sup>va</sup>' above it. The fourth system is labeled 'G or D string' and includes a dashed line with '8<sup>va</sup>' above it. The fifth system is labeled 'G string' and includes a dashed line with '8<sup>va</sup>' above it. Each system contains six measures of music, with the first measure of each system starting with a natural sign on the first line of the treble clef staff.

Figure 23 (Artificial Harmonic Exercise 1)

2 31  $8^{va}$   
G or D string

37  $8^{va}$   
G string

43  $8^{va}$   
G or D string

49  $8^{va}$   
G string

55  $8^{va}$   
G string

61  $8^{va}$   
G or D string

Figure 23 (Continued)

The image shows a musical score for two staves. The top staff is in treble clef and contains a sequence of notes: G4, A4, B4, C5, B4, A4, G4, F4, E4, D4, C4. Above the first measure is the number '67' and the symbol '8va'. A dashed line spans the top of the staff from the first measure to the end. The bottom staff is in bass clef and contains a sequence of notes: G2, A2, B2, C3, B2, A2, G2, F2, E2, D2, C2. A dashed line spans the bottom of the staff from the first measure to the end. The label 'G string' is positioned between the two staves. The piece concludes with a double bar line and the number '3' at the end.

Figure 23 (Continued)

## Artificial Harmonics Exercise 2: Tonic/Dominant in Circle of Fifths

Jeff Denson

The musical score consists of six systems, each with two staves. The top staff is labeled 'Sounding Pitch' and the bottom staff is labeled 'Written'. The time signature is 3/4. A dashed line labeled '8va' spans the first four measures of each system. The key signature starts with one flat (B-flat) and changes to two flats (B-flat and E-flat) after the second system. The exercise is 24 measures long, with measure numbers 5, 9, 13, 17, and 21 marked at the beginning of their respective systems. A signature 'JD' is located at the bottom right of the page.

Figure 24 (Artificial Harmonic Exercise 2)

2

The image displays a musical score for piano, consisting of six systems of music. Each system is marked with a measure number (25, 29, 33, 37, 41, 45) and a dynamic marking of *8<sup>va</sup>*. The notation is written for the right and left hands on grand staves. The right hand part features a melodic line with eighth and sixteenth notes, while the left hand provides a harmonic accompaniment with chords and moving bass lines. The key signature is one flat (B-flat major or D minor), and the time signature is 4/4. The score concludes with a double bar line at the end of the sixth system.

Figure 24 (Continued)

### Artificial Harmonic Exercise 3: Major Scale Sequences Jeff Denson

Sounding Pitch

Written

8<sup>va</sup>

G string

5

9

13

D string

or D string      G string      D string

17

21

25

G string

Figure 25 (Artificial Harmonic Exercise 3)

2

29  $8^{va}$

33  $8^{va}$

37 D string  
or D string ----- G string ----- D string

41

45

49 D string  
or D string ----- G string ----- D string

53

Detailed description: This figure shows a musical score for guitar, continuing from the previous page. It consists of seven systems of music, each with a treble and bass staff. The key signature has one flat (B-flat). Measure numbers 29, 33, 37, 41, 45, 49, and 53 are indicated at the start of each system. The notation includes eighth and quarter notes in the treble staff and chords in the bass staff. A dynamic marking of  $8^{va}$  (octave) is present at measures 29 and 33. At measure 37, there are specific string assignments: 'D string' for the first note, and 'or D string', 'G string', and 'D string' for subsequent notes. The score concludes with a double bar line at measure 53.

Figure 25 (Continued)

The musical score consists of seven systems, each with a piano part (treble and bass clefs) and a string part (treble clef). Measure numbers 57, 61, 65, 69, 73, 77, and 81 are indicated at the start of each system. The piano part features a melodic line with various intervals and accidentals, while the bass part provides harmonic support with chords and single notes. The string part includes a melodic line in the treble clef and a bass line in the bass clef. Specific string assignments are noted: 'G string' for measures 61-65 and 'D string' for measures 73-77. A 'Gua' marking is present above the piano part in measures 61, 65, and 69. The score concludes with a double bar line and repeat dots at the end of measure 81.

Figure 25 (Continued)

4

85 *8va*  
G string

89 *8va*

93 *8va*

97  
D string  
or D string - G string - D string

101

105

109 *8va*  
D string  
or G string

Figure 25 (Continued)

113 *8va*

117 *8va*

121 *8va*  
G string

125 *8va*

129 *8va*

133  
D string  
or D string G string D string

137

The musical score consists of seven systems of two staves each. The upper staff is in treble clef and contains a melodic line with various accidentals (sharps and naturals) and a repeat sign at the end of each system. The lower staff is in bass clef and contains chordal accompaniment. The key signature has one sharp (F#). The systems are labeled with measure numbers 113, 117, 121, 125, 129, 133, and 137. A dynamic marking of *8va* is present at the start of each system. Specific string assignments are noted: 'G string' under system 121, and 'D string' and 'or D string G string D string' under system 133.

Figure 25 (Continued)

6

141

The musical score consists of two staves, a treble clef on top and a bass clef on the bottom. The key signature has one sharp (F#). The treble staff begins with a treble clef and a sharp sign. The melody starts on a half note G4, followed by quarter notes A4, B4, C5, D5, E5, F#5, G5, and ends with a whole note G5. The bass staff begins with a bass clef and a sharp sign. The accompaniment consists of chords: G4-B4-D5, A4-C5-E5, B4-D5-F#5, C5-E5-G5, D5-F#5-A5, E5-G5-B5, and F#5-A5-C6. The piece concludes with a double bar line and repeat dots.

Figure 25 (Continued)

## Artificial Harmonics Exercise 4: Chromatic Scales

Jeff Denson

The image displays a musical score for "Artificial Harmonics Exercise 4: Chromatic Scales" by Jeff Denson. The score is presented in four systems, each consisting of two staves: "Sounding Pitch" (top) and "Written" (bottom). The music is in 4/4 time and features a chromatic scale in the right hand, with artificial harmonics indicated by a small circle above the notes. The left hand provides a harmonic accompaniment of chords. The systems are numbered 1, 8, 15, and 22, indicating the starting measure for each system. The key signature changes from one sharp (F#) to one flat (Bb) across the systems.

Figure 26 (Artificial Harmonic Exercise 4)

## HARMONIC CHORD GENERATIVE PRACTICES

### Raking

Raking is a performance technique that can be created either pizzicato or with the bow. This is when you strike the strings in rapid succession (in one motion), either from top string to bottom string or the reverse, causing the chosen notes from the strings to ring together as a chord or cluster. This is a particularly dramatic effect, and an invaluable one for the creation of harmonic chords on the bass. When generating this effect pizzicato the artifacts (noise-to-pitch ratio) can be a bit too high, therefore better results can be achieved by raking the strings behind the left hand with the fleshy part of the thumb. The attack will generally be less pronounced here due to the shorter string length from the left hand to the nut; the shorter string length results in the strings being more taut than on the opposite side of the hand.

The following is an example of a D major triad in second inversion raked with the bow from my arrangement of Duke Ellington's "I Got It Bad."



Figure 27 "Raking"

### Arpeggiated Chords

This technique is related to the “raking” technique, however it differs in velocity and articulation of attacks. Here all of the notes are individually articulated, and thus due to the physicality of the movements required, it obviously requires more time to generate than the all-in-one motion of the “raking” technique. This technique can have a harp or guitar-like quality to it (especially when produced with pizzicato artificial harmonics), which can be used as an expressive compositional or improvisational device, as well as being a practical approach to creating chords with notes that are not available as natural harmonics. In order to allow the artificial harmonics to ring together, notes must be chosen which are in a close enough proximity to one another to be accessible in one left hand position. Another point of consideration here is that when attacking (plucking or bowing) each individual note, careful attention must be paid to not make contact with any of the other previously attacked strings, in order not to interrupt the ringing of the note.

The following is an example of an arpeggiated A 9 chord in first inversion with the 7 resolving to the 9 from my arrangement of Duke Ellington’s “I Got It Bad.”

”

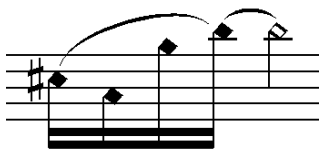


Figure 28 “Arpeggiated Chord

## **Combining Natural Harmonics with Stopped Notes and/or Open Strings**

Due to the aforementioned pitch limitations inherent in the use of natural harmonics on the double bass, the addition of stopped notes and/or open strings to a chord comprised of harmonics increases its tonal applications. Another attractive aspect of this combination is the richness of sound created due to its intrinsic open range of at least an octave or more. The first and most obvious choice of a combination would be to use the fundamental of the chord as the stopped note or open string at the bottom, in root position. Of course this is not the only option, merely the first and perhaps most fundamental. With that being said, one shouldn't overlook the importance of harmonic clarity (i.e. application of harmony) in voice leading. Naturally, the options remain for inversions and rootless voicings. Another possibility, contrary to that of the "open" voicing achieved when the fundamental is a stopped note or open string placed at the bottom of the chord, is the use of stopped notes in the upper register (thumb position) of the bass. Here, although there is a timbral difference between the upper-register stopped note/s and the harmonic/s, there is a blending of registers, hence creating a "closed" voicing. One issue to consider when using this type of combination is the intrinsic dynamic difference between stopped notes and harmonics; one should keep this in mind when each note is attacked in order to ensure the desired balance between all the pitches used in the given chord.

The Harvard Dictionary of Music defines a chord as a "simultaneous sounding of three or more tones;" with this in mind, there are nine different possible combinations of stopped-note and/or open strings and natural harmonic chords when

using a standard four string double bass. (Open strings can be substituted for stopped notes in the following combinations whenever possible or desired.) The three note combinations include: three stopped notes, three natural harmonics, one stopped note with two natural harmonics, and finally two stopped notes with one natural harmonic. The four note combinations include: four stopped notes, four natural harmonics, three stopped notes with one natural harmonic, two stopped notes with two natural harmonics, and finally one stopped note with three natural harmonics. Though all of these options are technically possible, and can all be used to great effect, the question of harmonic clarity must always be addressed when combining pitches in the lower registers in order to insure that the sound does not become too muddy. The innate clarity of higher pitch combinations is of course a benefit that can be most effectively attained on the double bass through the employment of harmonics, and with this logic the most “harmonically” clear of the above mentioned combinations are those that incorporate the greatest number of natural harmonics.

The following figure is from my arrangement of Duke Ellington’s “I Got It Bad”, demonstrating a G major 7 #11 chord with the bow.



Figure 29 “Combination: Stopped Note and Natural Harmonics”

## Combinations Expounded

The next and most natural option when looking to expand the tonal applications for chords in harmonics on the double bass is to add the use of artificial harmonics. Through the combination of different harmonic techniques, such as natural and artificial harmonics, as well as the use of stopped notes or open strings, chords that otherwise could not be created become possible.

The following figure is from my arrangement of Duke Ellington’s “Come Sunday”, demonstrating an example of the combination of two different types of harmonics and one stopped note. The first D (beat 1) can be played with the third finger, and then glissed up a half step to access the E flat. While keeping the third finger down (to enable the E flat to continue to ring), the A (3<sup>rd</sup> partial of the D string) is played as a natural harmonic with the first finger, and finally (being sure to keep both pitches ringing) the F is played as a stopped note on the A string.

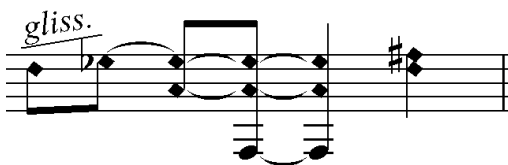


Figure 30 “Combinations”

## Scales in Natural Harmonics

G Lydian

G2 A4 E6 A5 D4 A6 D5 G4 G4 D5 A6 D4 A5 E6 A4 G2

5 A Mixolydian

A4 E6 A5 D4 A6 D5 G4 D6 D6 G4 D5 A6 D4 A5 E6 A4

9 D Mixolydian

D4 A6 D5 G4 D6 G5 D7 G6 G6 D7 G5 D6 G4 D5 A6 D4

13 B Aeolian

G6 A5 D4 A6 D5 G4 D6 G5 G5 D6 G4 D5 A6 D4 A5 G6

17 E Aeolian

A6 D5 G4 D6 G5 D7 G6 D9 D9 G6 D7 G5 D6 G4 D5 A6

21

E2 G2 A4 E3 D2 A3 A3 D2 E3 A4 G2 E2

Figure 31 (Scales in natural harmonics)

## CHORD CHARTS

### 3 Note Chords: 2 Natural Harmonics with Open E String

The musical score consists of seven systems, each with a treble and bass staff. The chords and their notes are as follows:

- System 1 (Measures 1-12):**
  - Measures 1-3: G2 D2 (G2, D2)
  - Measures 4-5: G3 D2 (G3, D2)
  - Measure 6: G7 D2 (G7, D2)
  - Measures 7-8: G8 D2 (G8, D2)
  - Measures 9-10: G9 D2 (G9, D2)
  - Measures 11-12: A5 D2 (A5, D2)
- System 2 (Measures 13-24):**
  - Measures 13-14: D3 G2 (D3, G2)
  - Measures 15-16: D7 G2 (D7, G2)
  - Measures 17-18: D8 G2 (D8, G2)
  - Measures 19-20: D9 G2 (D9, G2)
  - Measures 21-22: A5 G2 (A5, G2)
  - Measures 23-24: A7 G2 (A7, G2)
- System 3 (Measures 25-36):**
  - Measures 25-26: G7 D3 (G7, D3)
  - Measures 27-28: G8 D3 (G8, D3)
  - Measures 29-30: G9 D3 (G9, D3)
  - Measures 31-32: A4 D3 (A4, D3)
  - Measures 33-34: A5 D3 (A5, D3)
  - Measures 35-36: A6 D3 (A6, D3)
- System 4 (Measures 37-48):**
  - Measures 37-38: D7 G3 (D7, G3)
  - Measures 39-40: D8 G3 (D8, G3)
  - Measures 41-42: D9 G3 (D9, G3)
  - Measures 43-44: G4 D4 (G4, D4)
  - Measures 45-46: G5 D4 (G5, D4)
  - Measures 47-48: G6 D4 (G6, D4)
- System 5 (Measures 49-60):**
  - Measures 49-50: A9 D4 (A9, D4)
  - Measures 51-52: D6 G4 (D6, G4)
  - Measures 53-54: D7 G4 (D7, G4)
  - Measures 55-56: D8 G4 (D8, G4)
  - Measures 57-58: D9 G4 (D9, G4)
  - Measures 59-60: A7 G4 (A7, G4)
- System 6 (Measures 61-66):**
  - Measures 61-62: G9 D5 (G9, D5)
  - Measures 63-64: A7 D5 (A7, D5)
  - Measures 65-66: D7 G5 (D7, G5)
- System 7 (Measures 67-72):**
  - Measures 67-68: G5 D6 (G5, D6)
  - Measures 69-70: G6 D6 (G6, D6)
  - Measures 71-72: G7 D6 (G7, D6)

Figure 32 (3-note chords: 2 harmonics w/ open e-string)

### 3 Note Chords: 2 Natural Harmonics with Open A String

The musical score consists of five systems, each with a treble and bass staff. The chords and their constituent notes are as follows:

- System 1 (Measures 1-12):**
  - Measure 1: G<sub>2</sub> D<sub>2</sub>
  - Measure 2: G<sub>5</sub> D<sub>2</sub>
  - Measure 3: G<sub>3</sub> D<sub>2</sub>
  - Measure 4: G<sub>7</sub> D<sub>2</sub>
  - Measure 5: G<sub>8</sub> D<sub>2</sub>
  - Measure 6: G<sub>9</sub> D<sub>2</sub>
  - Measure 7: D<sub>5</sub> G<sub>2</sub>
  - Measure 8: D<sub>3</sub> G<sub>2</sub>
  - Measure 9: D<sub>7</sub> G<sub>2</sub>
  - Measure 10: D<sub>8</sub> G<sub>2</sub>
  - Measure 11: D<sub>9</sub> G<sub>2</sub>
  - Measure 12: G<sub>3</sub> D<sub>3</sub>
- System 2 (Measures 13-24):**
  - Measure 13: G<sub>4</sub> D<sub>3</sub>
  - Measure 14: G<sub>5</sub> D<sub>3</sub>
  - Measure 15: G<sub>6</sub> D<sub>3</sub>
  - Measure 16: G<sub>7</sub> D<sub>3</sub>
  - Measure 17: G<sub>8</sub> D<sub>3</sub>
  - Measure 18: G<sub>9</sub> D<sub>3</sub>
  - Measure 19: D<sub>4</sub> G<sub>3</sub>
  - Measure 20: D<sub>5</sub> G<sub>3</sub>
  - Measure 21: D<sub>6</sub> G<sub>3</sub>
  - Measure 22: D<sub>7</sub> G<sub>3</sub>
  - Measure 23: D<sub>8</sub> G<sub>3</sub>
  - Measure 24: D<sub>9</sub> G<sub>3</sub>
- System 3 (Measures 25-36):**
  - Measure 25: G<sub>4</sub> D<sub>4</sub>
  - Measure 26: G<sub>5</sub> D<sub>4</sub>
  - Measure 27: G<sub>6</sub> D<sub>4</sub>
  - Measure 28: G<sub>7</sub> D<sub>4</sub>
  - Measure 29: G<sub>8</sub> D<sub>4</sub>
  - Measure 30: G<sub>9</sub> D<sub>4</sub>
  - Measure 31: D<sub>6</sub> G<sub>4</sub>
  - Measure 32: D<sub>7</sub> G<sub>4</sub>
  - Measure 33: D<sub>8</sub> G<sub>4</sub>
  - Measure 34: D<sub>9</sub> G<sub>4</sub>
  - Measure 35: G<sub>4</sub> D<sub>5</sub>
  - Measure 36: G<sub>5</sub> D<sub>5</sub>
- System 4 (Measures 37-43):**
  - Measure 37: G<sub>6</sub> D<sub>5</sub>
  - Measure 38: G<sub>7</sub> D<sub>5</sub>
  - Measure 39: G<sub>8</sub> D<sub>5</sub>
  - Measure 40: G<sub>9</sub> D<sub>5</sub>
  - Measure 41: D<sub>7</sub> G<sub>5</sub>
  - Measure 42: D<sub>8</sub> G<sub>5</sub>
  - Measure 43: D<sub>9</sub> G<sub>5</sub>
- System 5 (Measures 44-50):**
  - Measure 44: G<sub>5</sub> D<sub>6</sub>
  - Measure 45: G<sub>6</sub> D<sub>6</sub>
  - Measure 46: G<sub>7</sub> D<sub>6</sub>
  - Measure 47: G<sub>8</sub> D<sub>6</sub>
  - Measure 48: G<sub>9</sub> D<sub>6</sub>
  - Measure 49: D<sub>8</sub> G<sub>6</sub>
  - Measure 50: D<sub>9</sub> G<sub>6</sub>

Figure 33 (3-note chords: 2 natural harmonics w/ open a-string)

## **Pieces**

# Come Sunday

Duke Ellington arr. Jeff Denson

let harmonics ring

gliss.

P.A.H.-----

L.H. Pizz

5 A.H.-----

gliss.

gliss.

let ring together

9 let ring

gliss.

gliss. molto vibr.

P.A.H.-----

L.H. Pizz.

13 A.H.-----

gliss.

let ring

17 Pull

Vibr.

21 Pull

Pull

gliss.

Rit.-----

w/ thumb

25 gliss.

gliss.

P.A.H.-----

L.H. Pizz.

29 A.H.-----

gliss.

gliss.

gliss.

33

gliss.

37

gliss.

gliss.

41

gliss.

gliss.

let bi-tone ring (major 3rd)

45

gliss.

A.H.

P.A.H. (N.H.)

3

3

p

49

gliss.

p

53

gliss.

gliss.

gliss.

57 Pull

Vibr.

61 Pull Pull *gliss.*

Rit.-----

w/ thumb

65 *gliss.* *gliss.* P.A.H.-----

L.H. Pizz.

69 P.A.H.----- *gliss.* *gliss.* *gliss.*

*gliss.*

# I Got It Bad

Duke Ellington arr. Jeff Denson

*let ring*

*let ring*

*vibr.*

*L.H. Pizz.*

5

*fast full bow*

*let ring*

9

*let ring*

*vibr.*

*L.H. Pizz.*

13

*let ring*

*subito*

*mp* *mf* *mp*

17 *legato*

*gliss.*

*let ring*

21 *sul tasto*

*gliss.*

*let ring*

*gliss.*

A3

25

D10 D9 D9 G6

let ring

29

let ring G6 D7 A6 G5 D6

vibr. vibr.

33

L.H. Pizz. L.H. Pizz.

37

rubato

L.H. Pizz.

molto rubato-----

vibr. top notes-----

let ring

## CONCLUDING THOUGHTS

When I began my research, it was my intention to explore the possibilities for the creation of chords in harmonics (or overtones) on the double bass and how they could be used in tonal music, much like a guitar or piano. Although I have found various options for achieving this goal, the most valuable fruits of my research lie in the possibilities for melodic expression and the creation of textural landscapes. The various harmonic generative techniques that I have explored throughout this investigation lend themselves to the creation of beautiful and expressive melodic textures that transcend the depths of the double bass's low range and robust timbre by enabling register leaps of up to more than three octaves with light, singing tones with crystal clarity. These harmonic generative techniques add even more range, as well as timbral variations to the double bass's already expansive pallet of available sounds.

The variety of harmonic generative techniques I have discussed in this paper allow for new and different voices or characters to emerge from the double bass. These "voices" or "characters" make the double bass an even more dynamic and diverse instrument that can play a variety of musical roles, each with their own unique and distinctive qualities. The transposable harmonic techniques, such as harmonic specific flautando or falsetto bowing and pizzicato and arco artificial harmonics, can function melodically in an almost limitless capacity; they can be navigated through any given harmony or chord sequence. The important points that must be considered here are the limited dynamic ranges of harmonic-specific flautando or falsetto bowing and pizzicato artificial harmonics, as well as the issues of their playability. These

techniques open up whole new worlds of timbral possibilities for composers and improvisers.

In a tonal context, artificial (arco and pizzicato) harmonics are of extreme value to the composer and/or improvising performer. Due to the fact that any chromatic pitch is accessible, and the ability to individually tune any note, as is common practice with the playing of fundamentals, opens this harmonic generative technique to almost limitless potential. This is a technically demanding technique where the possibilities for its use depend greatly on the skill level of the player and their experience with its performance; nonetheless a high level of virtuosity can be attained. The precedent has been set for its seamless interweaving within moving lines mixed with fundamental pitches by bassists such as François Rabbath and Renaud Garcia-Fons.

A new level of virtuosity is made possible and can be attained with the leaping of registers through the intermixing of fundamental pitches with partials, and even harmonics of partials (i.e. bi-nodal and multi-nodal harmonics). This type of feat would be utterly impossible without the use of these techniques. Not only can the implementation of harmonics interspersed with fundamental pitches allow for incredibly difficult, if not otherwise impossible, leaps within the range of the fingerboard, it allows for leaps that transcend the instrument's expected realm of sonic possibilities and enter into those of the upper orchestral strings! These leaps of register are truly fantastic both for the listener and the bassist, as well as for the composer who understands the sheer magnitude of the physical distance that the bassist must move their hand in order to play a mere three-octave scale.

Dramatic sound worlds can be created through the juxtaposition of harmonics and fundamental pitches. Here, this combination of the airy, ethereal sound of the harmonics with the earthy, corporal-vibrating sound of the fundamentals, either through fingered pitches or open strings, exploit the extreme opposite ends of the expansive range of the double bass within one texture. Such a wide variety of timbre allows for the illusion of different instruments; this is a great attribute that has been explored through the work of a number of contemporary composers and improvisers, and yet its enormous potential is still largely untapped.

I see my research on this topic as a beginning, and not an end. I feel that I have opened windows for myself through which I can discover endless sources of inspiration for both composition and improvisation. With this material, I believe there lies possibilities to re-frame the contextualization of the double bass in its roles as both a solo and supportive instrument, and as a harmonic (as in foundation of the harmony) instrument in a jazz and/or improvised music rhythm section.

## BIBLIOGRAPHY

- Apel, Willi. *Harvard Dictionary of Music*.  
Cambridge: The Belknap Press of Harvard University Press, 1969.
- Bernstein, Leonard. *The Unanswered Question: Six Talks at Harvard*.  
Cambridge: Harvard University Press, 1976.
- Blatter, Alfred. *Instrumentation and Orchestration*.  
United States: Schirmer, 1997.
- Brun, Paul. *A New History of the Double Bass*.  
Villeneuve d' Ascq: Paul Brun Productions, 2000.
- Dresser, Mark. "A Personal Pedagogy," *Arcana: Musicians on Music*.  
New York: Granary Books, Inc., 2005
- Dresser, Mark. "Double Bass Harmonics," *The Strad*  
Oct. 2008 Vol. 119, Iss. 1422, pp.108-111
- Green, Barry. *Advanced Techniques of Double Bass Playing: Part 1 & 2*.  
Cincinnati: Piper, 1976.
- Goliav, Yoan. *The Double Bass: A Philosophy of Playing*.  
Quebec: Les Editions Doberman-YPPN, 2003.
- Just Intonation Network, The. "What is Just Intonation?"  
[www.justintonation.net](http://www.justintonation.net) (accessed September, 10, 2008).
- Levitin, Daniel J. *This is Your Brain on Music: The Science of Human Obsession*.  
New York: Dutton, 2006.
- Nanny, Edouard. *Enseignement Complet de la Contrebasse a 4 et 5 cordes*.  
Paris: Alphonse Leduc & Cie, 1920.
- Payton, Leonard Richard. *Contrabass Harmonic Potential: A Study in Acoustics and Composition*. Doctoral Dissertation,  
University of California at San Diego, 1988.
- Peer, Dan. *Bass Harmonics: New Concepts and Techniques*.  
Van Nuys: Alfred.
- Piston, Walter. *Harmony*.

New York: W.W. Norton and Company, Inc., 1987

Rabbath, Francois. *Nouvelle Technique De La Contrebasse: Methode Complete Et Progressive: En Trois Cahiers: 3.*  
Paris: Alphonse Leduc & Cie Editions Musicales, 1984.

Robert, Jean-Pierre. *Modes of Playing the Double Bass.*  
Paris: Musica Guild, 1995.

Simandl, Franz. *New Method for the Double Bass: Book II.*  
New York: Carl Fisher, 1987.

Strange, Patricia and Allen. *The Contemporary Violin: Extended Performance Techniques.*  
Berkeley: University of California Press, 2001.

Turetzky, Bertram. *The Contemporary Contrabass.*  
Berkeley: University of California Press, 1974.

Woodrich, Dennis Lane, "Multi-Nodal Performance Technique for Contrabass Harmonics." Master's Thesis,  
University of California at San Diego, 1980.

## SCORES

Bottesini, Giovanni. *Fantasia Lucia di Lammermoor.*  
Bryn Mawr: Theodore Presser, 1962.

Dittersdorf, Karl Ditters Von. *Concerto in E Major.*  
Kirkwood, NJ: JAH Publications, 1993.

Dragonetti, Domenico. *Concerto in A Major.*  
New York City: International Music Company. 1963.

Hindemith, Paul. *Sonata for Double Bass and Piano.*  
London: Schott & Co. 1950.

Henze, Hans Werner. *S. Biagio 9 Agosto ore 1207: Ricordo per un Contrabbasso Solo.*  
Mainz: B. Schott's Sohne. 1980.

Luykenaar, Ceez. *For Harmonics Only: Double Bass Solo.*

Amsterdam: Donemus. 1976.

Perel, George. *Monody II for Solo Double Bass*.  
Bryn Mawr: Theodore Presser Company. 1966.

Persichetti, Vincet. *Parable for Solo Double Bass*.  
Bryn Mawr: Elkan-Vogel, Inc. 1975.

### **Recordings**

Dresser, Mark. *Unveil*. Clean Feed Records. CF043CD, 2005.

Garcia-Fons, Renaud. *Arcoluz*. Enja Records. LC03126, 2005.

Parker, William. *Lifting the Sanctions*. NoMoreRecords. No. 6, 1997.

Pastorius, Jaco. *Jaco Pastorius*. Epic Records. EK33949, 1976.

Scodanibbio, Stefano. *Voyage that Never Ends*. New Albion Records. NA101CD,  
1998.