

Heady Harmonocosms
The Honors College, Florida International University
IDH 3034,3035/4007,4008 Fall 2011/Spring 2012
Instructor: David A. Becker

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Office Hours (Fall Semester) Fridays from 9:50-10:50 AM or by appointment

“Nature geometrizeh and observeth order in all things”
-Sir Thomas Browne

Imagine taking twelve particular keys of a piano (the seven white keys and five black keys from a C such as Middle C to the note before the next higher C) and placing the name of each tone assigned to these twelve piano keys onto a fascinating and obscure twelve-faced three-dimensional object so that one tone appears on each of the twelve faces in a certain arrangement. Now imagine that, of the millions of possible arrangements, the certain arrangement put into place allows the chord sequences and even melodies of a huge number of popular rhythm and blues songs to be easily visualized by traveling in a continuous path that connects the quadrilateral faces of this mysterious gem-like object. And that's not all. New songs with appealing qualities can be composed with the device. How is this possible? Embark on a journey that bridges music with geometry, and that finds manifestations of mutuality between these areas and the realms of molecular biology and animal morphogenesis.

Course Requirements:

The course will be conducted as a seminar. Students are expected to come to class prepared and participate fully in the discussions. Assignments must be submitted on time. Attendance is mandatory and tardiness is unacceptable. All students must adhere to the Academic Integrity Policy of The Honors College and Florida International University.

Course Learning Outcomes:

Students will acquire skills involving the use of geometry in the analysis and composition of music exhibiting Western harmony and will gain an appreciation for geometric principles with interdisciplinary applicability. The course fosters global learning by encouraging students to carefully contemplate the common biological patterning in all humans and to express their innate creativity in the context of the universal languages of music and geometry. The original musical composition prepared by each student enhances the student's appreciation of the Arts and may constitute a project worthy of addition to the student's Honors College Portfolio.

Assignments and Grading Structure:

Fall Semester: Midterm – 25% of final grade; Final Exam – 35% of final grade;
Dodecahedral Analysis of an approved composition by an artist of the student's choosing
– 40% of final grade.

Required Texts and Materials:

- David A. Becker, *Incarnations of the Blaring Bluesblinger: A Multimedia Mathmantra on Manifestations of Mutuality in Music, Molecules, and Morphogenesis*, San Diego, CA, University Readers, 2010, ISBN: (978-1-609279-55-4), 338 pages, \$109.00.
- Thomas Browne, *The Garden of Cyrus*, available on-line at the following URL: <http://penelope.uchicago.edu/gardenframes/gardenn.html>
- Istvan Hargittai, Magdolna Hargittai, *Symmetry: A Unifying Concept*, Bolinas, CA, Shelter Publications, Inc., 1994, ISBN-13: 978-0898155907, 222 pages, (new or used copies of this book are available for purchase for approximately twenty dollars from such on-line providers as amazon.com)
- Joscelyn Godwin, *The Revival of Speculative Music*, *The Musical Quarterly*, Vol. 68, No. 3 (Jul., 1982), pp. 373-389 (this article is available from the FIU library)
- Nenad Trinajstić, *The Magic of the Number Five*, *Croatica Chemica Acta*, Vol. 66, No. 1, pp. 227-254 (this article will be provided by the instructor)
- Felix Mann, David Bowsher, Jim Mumford, Sampson Lipton, John Miles, *Treatment of Intractable Pain By Acupuncture*, *The Lancet*, 1973, Vol. 302, pp. 57-60 (contains a discussion of the traditional anatomical roles of pertinent numbers in Chinese medicine)

Other materials assigned by the instructor (such as video clips, music, etc.) will be provided with their respective URL's.

CLASS SCHEDULE (Fall Semester)

The last 15-30 minutes of each lecture will be devoted to the construction of an original dodecahedral composition as a collective class effort.

Date	Topic
8/22	Overview, 3-D music?, Platonic Solids, Duals, Convex polyhedra, Kepler's 1619 rhombic dodecahedron from "Harmonice Mundi", Origami and a particular intonation of the rhombic dodecahedron (each student will construct an origami rhombic dodecahedron), Discussion of the chapter entitled "Cubes and Other Polyhedra" from the textbook "Symmetry: A Unifying Concept", A listen to some music from intonated rhombic dodecahedra.
8/29	Calculating distinct intonations of the rhombic dodecahedron, Other geometric entities described by the face centers of a rhombic dodecahedron, Polyhedra in nature, A discussion of Sir Thomas Browne's book "The Garden of Cyrus", Quincunxes.
9/12	Twelve quincunxes in a cube, Douthett and Steinbach's "Cube Dance", Chord theory, Tertian harmony, Triads, tetrads, and pentads, The predominant preclusion of tone clusters in tonal music, Jazz and pentads, Pascal's triangle and chord enumeration, Why a twelve-tone system?, Yin/Yang and the Circle of Fifths, 1,4,5 and the Circle of Fifths, Major/Minor and 1,4,5 triads in Euler's 1739 tonnetz, Euler and the birth of graph theory.
9/19	Crucial 1,4,5 pentadic relationships in a particularly intonated rhombic dodecahedron, Consonance and dissonance in balance, Fuller and polyhedral balance, Tonal seeding of the rhombic dodecahedron. Video of Leonard Bernstein discussing the importance of dissonance in a 1957 Omnibus telecast.

- 9/26 Schlegel diagrams, Cuboctahedral graphs, Seeding a cuboctahedral graph, Non-convex polyhedra, Neighboring and non-neighboring chords, Multiple chord qualities for a given polytonic set, Case Study: “The Long and Winding Road” by the Beatles.
- 10/3 Chord progressions that require cuboctahedral graph relatives such as the anticuboctahedral graph, The famous Kepler Conjecture concerns both the cuboctahedron and the anticuboctahedron, Duality of the anticuboctahedron/trapezo-rhombic dodecahedron, Classification of the anticuboctahedron as a Johnson Solid, Planar quartic graphs, Planar graphs and the sphere, Other planar quartic graphs on twelve vertices, The bluesblinger graph.
- 10/10 A highly ordered jazz/blues intonation of the bluesblinger graph, Visualization of the bluesblinger dodecahedron, Steinitz’s Theorem, The convex bluesblinger dodecahedron (each student will construct an Origami bluesblinger dodecahedron), The bluesblinger dodecahedron’s notable bilateral symmetry, Non-convex versions of the bluesblinger dodecahedron, Non-manifold edges, Geometric analysis of the original music piece “Code of Blues”, The centered collinear tritone pair midpoints within the Schlegel representation of the bluesblinger code, Application of the bluesblinger code in the analysis of some popular songs in the blues and jazz genres. The twelve pentatonic sets of the bluesblinger code.
- 10/17 Midterm
(prior to the exam, students should, in writing, submit their chosen song for analysis in order to gain approval)
- 10/24 Further analysis of other dodecahedral compositions in a range of genres. Dodecahedral analysis of the Miles Davis classic “All Blues”, The path-specific geometrical methodology within the original piece “Clock Voices”.

- 10/31 Guest lecture (TBA)
- 11/7 Music and body plan in Godwin's article "The Revival of Speculative Music", Discussion of the first chapter entitled "Bilateral Symmetry" within the book "Symmetry: A Unifying Concept", Cadherin proteins and cell adhesion, The pentameric classic cadherin extracellular repeat domains, The thirteen type II classic cadherins in vertebrates, The role of cadherins in brain wiring, Recent work concerning type II cadherins and autism, Cadherin networks and the bluesblinger graph, Versions of the bluesblinger dodecahedron as generalized cephalic/brain scaffolds. The icosahedron in virology. Henry Gray's bluesblinger pharynx?
- 11/14 Animal skulls resembling the bluesblinger dodecahedron, Anatomical occurrence of the number twelve, Twelve cadherin superfamily members in a code for a brain subunit , Twelve homeobox genes expressed in the developing mammalian head, The strong biological link between bilateral symmetry and cephalization, Paul Flechsig's twelve primary myelination zones in the developing brain, Petkov's fields of the monkey auditory cortex, axial morphogenesis.
- 11/21 Students present and submit their dodecahedral analyses, Performance of the original class song.
- 11/28 Review session for final exam.
- 12/5 Final Exam

Spring Semester: Midterm – 25% of final grade; Final Exam – 35% of final grade; Composition of an original piece of tonal music with the dodecahedral methodology– 40% of final grade (the song must employ all twelve pentatonic sets)

The last 15-30 minutes of each lecture will be devoted to the construction of an original dodecahedral composition as a collective class effort.

- 1/9 The class, guided by the instructor, conducts research to examine whether salt/hydrogen bridges can offer insight into Shimoyama's cadherin network based upon cadherin amino acid sequences. The antiparallel binding hypothesis.
- 1/23 A balance of autobiographical consonances and dissonances in the instructor's encountered pathways, A longstanding friendship with esteemed jazz guitarist Randy Bensen, Discussions with jazz guitarist Pat Metheny concerning dodecahedral music, A listen to Coltrane's classic harmonic masterpiece "Giant Steps", Jazz guitarist Pat Martino's geometric analysis of "Giant Steps", Dodecahedral analysis of "Giant Steps".
- 1/30 Martino's "Giant Steps" analysis and a crucial graph of Kuratowski's Reduction Theorem, Pat Metheny's composition "(It's Just) Talk", Dodecahedral analysis of the head to Metheny's "(It's Just) Talk".
- 2/6 Tymoczko's admirable goal of mapping all chords with orbifolds from string theory, A present dearth of pentachord orbifold maps, Physicist's focus on string theory in 10-D and 11-D, Is there a hexatonic analog to the paradigmatic pentachord-based intonation of the rhombic dodecahedron?, Does the orbifold approach posit that cardinality five is special? Expanding pentatonic sets into heptatonic sets, Expansion of diatonic pentatonic sets, Expansion of non-diatonic sets, The context-dependence of tone set expansions.
- 2/13 Geometric analysis of the blues scale (the first half of this session involves students working independently on this 3-D analysis), 3-D geometric analysis of the major scale, The "chalice" graph via graph contraction, The chalice graph applied to James Taylor's composition "Your Smiling Face" (the class will listen to the piece).

- 2/20 A listen to Carlos Santana's and Tom Coster's "Europa", Analysis of "Europa" in three dimensions, "Europa's" nine tones on a halved Archimedean Solid, From Euler's 2-D tonnetz to the paradigmatic intonation of the 3-D rhombic dodecahedron, "Europa's" bass line and the seven tones of a halved Circle of Fifths.
- 2/27 Midterm
- 3/5 Consonance and functional dissonance in overall balance, The twin dodecahedral progeny of the Circle of Fifths, Medial and lateral as a ramification of bilateral symmetry, A discussion of pertinent aspects of Chinese medicine as highlighted in the assigned 1973 article from the Lancet. A discussion of the assigned article "The Magic of the Number Five", Pentagonal numbers, Fermions in particle physics, Morphogenetic parallels of prominent tonal geometries. Amphids, tergites, and opisthosomas.
- 3/19 A musical idol from the instructor's childhood (Jaco Pastorius), Randy Bernsen and Jaco Pastorius, Some famous music of Jaco Pastorius, Recordings featuring Bernsen and Pastorius, Pastorius and "The Sound of Music", Cuboctahedral analysis of "The Sound of Music".
- 3/26 Richard Rodgers and Harold Arlen, Chittenango and the yellow brick sidewalk, Harold Arlen's Syracuse connections, Arlen's recently discovered connections to the instructor's family, Connectivity, Cuboctahedral analysis of "Over the Rainbow", Epilogue.
- 4/2 Student concert featuring their original dodecahedral compositions as well as the original class composition. Students submit their compositions and respective geometric analyses to the instructor.
- 4/9 Concert with the Randy Bernsen Trio featuring a student composition selected by student vote.
- 4/16 Review Session

SUPPLEMENTARY READING

1. For a newly elucidated protein with cuboctahedral geometry, see: S.M. Stagg, C. Gurkam, D.M. Fowler, P. LaPointe, T.R. Foss, C.S. Potter, B. Carragher, W.E. Balch, "Structure of the Sec13/31 COPII coat cage", *Nature*, 2006, vol. 439, p. 234-238.
2. J. Douthett, P. Steinbach, "Parsimonious Graphs: A Study in Parsimony, Contextual Transformation, and Modes of Limited Transposition", *Journal of Music Theory*, 1998, vol. 42, p. 241-263.
3. H. W. Kroto, J. R. Heath, S.C. O'Brien, R.F. Curl, R.E. Smalley, "C₆₀: Buckminsterfullerene", *Nature*, 1985, vol. 318, p. 162-163.
4. J. Bennighof, "Set Class Aggregate Structuring, Graph Theory, and some Compositional Strategies", *Journal of Music Theory*, 1987, vol. 31, p. 51-98.
5. For a review of Euler's famous 1736 graph theory work, see: G.L. Alexanderson, "Euler and Konigsberg's bridges: a historical view", *Bulletin of the American Mathematical Society*, 2006, vol. 43, p.567-573.
6. N.W. Johnson, "Convex Solids with Regular Faces", *Canadian Journal of Mathematics*, 1966, vol. 18, p. 169-200.
7. a) M. Meringer, "Fast Generation of Regular Graphs and Construction of Cages", *Journal of Graph Theory*, 1999, vol. 30, p. 137-146. b) Markus Meringer's Regular Graphs website (www.mathe2.uni-bayreuth.de/markus/reggraphs.html)
8. D. Sipp, "Discovery and characterization of the cadherin superfamily of cell adhesion molecules. An interview with Masatoshi Takeichi.", *International Journal of Developmental Biology*, 2004, vol. 48, p. 387-396.
9. For a review of the cadherin superfamily, see: P. Hulpiau, F. Vanroy, "Molecular evolution of the cadherin superfamily", *The International Journal of Biochemistry and Cell Biology*, 2009, vol. 41, p. 349-369.
10. For a recounting of the seminal work on icosahedral virus structures, see: D.L.D. Caspar, "This Week's Citation Classic", *Current Contents*, 1984, vol. 27, p. 15.

- See also: D.L.D. Caspar, A. Klug, "Physical principles in the construction of regular viruses", Cold Spring Harbor Symp., 1962, vol. 27, p. 1-24.
11. Y. Shimoyama, G. Tsujimoto, M. Kitajima, M. Natori, "Identification of three human type-II classic cadherins and frequent heterophilic interactions between subclasses of type-II classic cadherins", Biochemical Journal, 2000, vol. 349, p. 159-167.
 12. N. Hertel, K. Krishna, M. Nuenberger, C. Redies, "A cadherin-based code for the divisions of the mouse basal ganglia", Journal of Comparative Neurology, 2008, vol. 508, p. 511-528. For a review of cadherins in morphogenesis and postulated cadherin adhesion mechanisms, see: J.M. Halbleib, W.J. Nelson, "Cadherins in development, cell adhesion, sorting, and tissue morphogenesis", Genes and Development, 2006, vol. 20, p. 3199-3214. For another example of morphogenesis involving a cadherin code comprised of type II classic cadherins, see: S.R. Price, N.V. De Marco Garcia, B. Rauscht, T.M. Jessell, "Regulation of motor neuron pool sorting by differential expression of type II cadherins", Cell, 2002, vol. 109, p. 205-216.
 13. H. Hakonarson et al., "Common genetic variants on 5p14.1 associate with autism spectrum disorder", Nature, 2009, vol. 459, p. 528-533.
 14. For a treatment of bilateral symmetry and cephalization, see: G.L. Grabowsky, "Symmetry, locomotion, and the evolution of an anterior end: a lesson from sea urchins", Evolution, 1994, vol. 48, p. 1130-1146.

University Requirements

Academic Honesty and Plagiarism

FIU Academic Misconduct Statement

Florida International University is a community dedicated to generating and imparting knowledge through excellence in teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and honestly to demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct that demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic

Misconduct procedures and sanctions, as outlined in the Honors College Student Handbook.

Academic misconduct includes:

- *Cheating – The unauthorized use of books, notes, aids, electronic sources, or assistance from another person with respect to examinations, course assignments, field service reports, class recitations or other work; or the unauthorized possession of examination papers or course materials, whether originally authorized or not. Cheating violates both University and College codes.*
- *Plagiarism – The use and appropriation of another’s work without any indication of the source, and the representation of such work as the student’s own. Any student who fails to give credit for ideas, expressions or materials taken from another source, including Internet sources, commits plagiarism. Plagiarism violates both University and College codes.*
- *Unacceptable behavior – Students who show repeated or egregious disrespect for classmates or instructors, are disruptive, or consistently violate course rules are subject to the sanctions of the Honors College.*

Registration in this course implies an acceptance of and compliance with the Honors College policies for students and the FIU Code of Academic Integrity. Please refer to the following documents for additional information:

FIU Code of Academic Integrity –
<http://www.fiu.edu/~dwyere/academicintegrity.html>

FIU Honors College Student Handbook –
<http://honors.fiu.edu/handbook0910.html>

FIU Honors College Plagiarism Policy –
http://honors.fiu.edu/current_policy_plagiarism.html

Religious Observances

Every effort will be made, where feasible and practical, to accommodate students whose religious practices coincide with class requirements or scheduling. Please make sure to notify your instructor at the beginning of the semester of which dates you will be absent or any anticipated problems with completing course work.

Physical, Mental and Sensory Challenges

Every effort will be made, where feasible and practical, to accommodate students

who are so challenged. Should you require accommodations, contact the Disability Resource Center, if you have not done so already.

Honors College Requirements

Student Portfolios

The Honors College will be using a portfolio method to assess students' learning outcomes. The portfolio method allows for maximum flexibility in gauging student learning. Students decide (with instructor consultation) what "artifacts" or assignments to include for consideration in their portfolios to demonstrate successful achievement of each of the student learning outcomes over the 4-year Honors experience. Portfolios provide a rich context for students to show what they have learned and to explain their learning process. Because the Honors curriculum is meant to be thought-provoking and reflective, student self-assessment through portfolios will facilitate learning and provide in-depth assessment. Each course will include at least one assignment that could potentially fit portfolio requirements. For more information on the student learning outcomes and constructing a portfolio for your senior year, see honors.fiu.edu/portfolios.

Citizenship Requirements

All members of the Honors College are expected to be active citizens of the College, the university, and the community at large. To be a committed Honors College student is to take advantage of enhanced learning opportunities and to assume a leadership role in the world. All College members are expected to participate in the community-building activities listed below:

1. Attend one Honors Excellence Lecture per academic year and one Honors Colloquium per semester (fall and spring). (Attendance will be taken).
2. Participate in the Honors College Convocation each Fall. (Attendance will be taken).
3. Attend at least three Honors Hour sessions per semester or enrichment events specified by the Honors College as satisfying this requirement. (Attendance will be taken).
4. Perform at least *twenty* hours of Community Service per academic year (summer excluded) either through the Honors College service

partnerships (Sweetwater, Overtown Youth Center, etc.) or through other community service projects and/or events. If you want to apply this service to your graduation portfolio, be sure to document your hours.

GL Learning Outcomes

GL Learning Outcomes for IDH 2003-4

- Global Awareness: Students will be able to demonstrate knowledge of the interrelatedness of local, global, international, and intercultural issues, trends, and systems.
 - ***Course Learning Outcome:*** Students will demonstrate knowledge of the interrelated dynamics (social-cultural, political, economic, etc.) that shape the actions of multiple figures in diverse cultural contexts.
- Global Perspectives: Students will be able to develop a multi-perspective analysis of local, global, international, and intercultural problems.
 - ***Course Learning Outcome:*** Students will be able to analyze the multiple causal forces that shape the perspectives of historical individuals/persons — economic, political, sociological, technological, cultural, etc.
- Global Engagement: Students will be able to demonstrate a willingness to engage in local, global, international, and intercultural problem solving.
 - ***Course Learning Outcome:*** Students will demonstrate a willingness to engage in negotiation regarding actions of global import within the context of the class simulation.

GL Learning Outcomes for IDH 3034-5

- Global Awareness: Students will be able to demonstrate knowledge of the interrelatedness of local, global, international, and intercultural issues, trends, and systems.
 - ***Course Learning Outcome:*** Students will demonstrate knowledge of the interrelated global dynamics (social-cultural, political, economic, etc.) that shape aesthetics, values, and authority in diverse cultural contexts.
- Global Perspectives: Students will be able to develop a multi-perspective analysis of local, global, international, and intercultural

problems.

- **Course Learning Outcome:** Students will be able to analyze the multiple global forces that shape their understanding of aesthetics, values, and authority — economic, political, sociological, technological, cultural, etc.
- Global Engagement: Students will be able to demonstrate a willingness to engage in local, global, international, and intercultural problem solving.
 - **Course Learning Outcome:** Students will be able to develop solutions to local, global, international, and/or intercultural problems related to aesthetics, values, and authority.

Assignments must be able to assess the students' ability to demonstrate these outcomes. We will be collecting them at the end of the academic year (spring).

Honors College Important Dates – Fall Semester

Convocation	October 5, 2011
Excellence Lecture	October 27, 2011
Fall Awards Assembly	December 2, 2011