# Math/Music: Aesthetic Links

## Research Paper: List of Composers

The following is a list of composers for the Research Paper due on April 13. Included are possible pieces for study or topics to investigate, and, in some cases, a relevant source. In the course of your research, you may find other pieces of interest for your paper. You are required to use at least four sources (historical, mathematical, musical, etc.). Contact Alan Karass (`akarass@holycross.edu`, 793-2295), the Music Librarian, for assistance in obtaining background materials and music.

1. Milton Babbitt
   - *Composition for Four Instruments*; *Three Compositions for Piano*
   - Extension of Schoenberg's twelve-tone method to include rhythm and timbre
   - Book: *The Math Behind the Music* by Leon Harkleroad (see pp. 51–54)
2. Johann Sebastian Bach
   - *The Musical Offering*; *The Well-Tempered Clavier*
3. Béla Bartók
   - *Mikrokosmos*, Book 6, BB 105: No. 141, *Subject and reflection*
   - *Music for Strings, Percussion and Celesta* (Use of the Golden Section and Fibonacci Numbers?)
   - Book: *Béla Bartók: an anaylysis of his music* by Ernő Lendvai
   - Article: "Bartók, Lendvai and the Principles of Proportional Analysis," by Roy Howat, *Music Analysis*, Vol. 2, No. 1 (Mar., 1983), pp. 69–95
4. Peter Maxwell Davies
   - *Ave maris stella*; *A mirror of whitening light*
   - Use of magic squares – see Chapter 8 of the primary course text. Composer's website: `http://www.maxopus.com/`
5. Claude Debussy
   - *La Mer* (Use of the Golden Section?)
   - Book: *Debussy in proportion: a musical analysis* by Roy Howat
6. Joseph Haydn
   - Famous retrograde in *Piano Sonata No. 41, Hob. XVI/26, "Minuet and Trio"* in A major, (reused in *Sonata No. 4 for Piano and Violin* as well as his *Symphony No. 47*)
7. Paul Hindemith
   - *Ludus Tonalis* ("Game of Tones") – see Chapter 6 of the primary course text

8. Sarah Hopkins
    - *Return to Joy*; harmonic overtone singing, Australian landscapes, Harmonic Whirlies (more overtones), handbells
    - Composer's website: `http://www.sarahhopkins.com/bio`
9. György Ligeti
    - *Études for piano*, Book I and II; Influence of fractal geometry on his music
    - Article: "Fractal dimension analysis of complexity in Ligeti piano pieces" by Rolf Bader, *Acoustical Society of America Journal*, Vol. 117, No. 4 (2005), pp. 2477–2477
10. Cindy McTee
    - *Einstein's Dream*; *Circle Music I-IV*; Composer's website: `http://www.cindymctee.com/`
11. Oliver Messiaen
    - Use of symmetry in time and pitch, non-retrogradable rhythms, and modes of limited transposition
    - *Quatuor pour la fin du temps* ("Quartet for the End of Time")
12. Wolfgang Amadeus Mozart
    - *Musikalisches Wurfelspiel* ("Musical Dice Game")
    - The Golden Section in his piano sonatas? See "The Golden Section and the Piano Sonatas of Mozart" by John F. Putz, *Mathematics Magazine*, Vol. 68, No. 4 (1995), pp. 275–282
13. Tristan Murail
    - *Désintégrations* – "spectral" technique, decomposition of sound using computers and mathematics
    - Composer's website: `http://www.tristanmurail.com/en/index.html`
14. Steve Reich
    - *Four Organs*; the use of simple phase shifting to create entire pieces
    - *Clapping Music* — See "Clapping Music – A Combinatorial Problem" by Joel K. Haack, *The College Mathematics Journal*, Vol. 22, No. 3 (1991), pp. 224–227
15. Arnold Schoenberg
    - Twelve-tone method of composition – see Chapter 8 of the primary course text
    - *Piano suite*, Op. 25; *Pierre Lunaire*, No. 18
16. Iannis Xenakis
    - *Metastasis*; *Pithoprakta*; see Chapter 8 of the primary course text
    - Book: *Formalized music; thought and mathematics in composition* by Iannis Xenakis