**ACTIVITY REPORTING FORM**
**ABEL VISTING SCHOLAR PROGRAM**

***(Deadline for completion: see grant letter)***

*The progress report should include a brief (one page) activity report prepared by each mathematician supported, listing research in progress, papers published or in preprint form, students and post-doctoral fellows advised and dates spent at the host Institution.*

*After consideration by CDC, the intention is that this activity report and pictures will be made publicly available on the CDC web site.*

1. Name of the Grantee: Octavio Alberto Agustín Aquino
2. Country of origin of the Grantee: **México**
3. Home institution of the Grantee: **Instituto de Física y Matemáticas, Universidad Tecnológica de la Mixteca**
4. Name of the institution visited: **School of Music, College of Liberal Arts, University of Minnesota**
5. Name, position and e-mail address of the host: **Guerino Mazzola, Professor, mazzola@umn.edu**
6. Dates of the research visit: **September 1st to September 30th, 2018.**

**1. Activity report (at least 400 words)** Listing research in progress, papers published or in preprint form

The following articles were written or extensively revised and improved.

- O. A. Agustín-Aquino and G. Mazzola, *Modulation in Tetradic Harmony and its Role in Jazz*, https://arxiv.org/abs/1809.04755. Submitted to the Journal of Mathematics and Music.

  **Abstract:** After a quick exposition of Mazzola's quantum modulation model for the so-called triadic interpretation of the major scale within the equal temperament, we study the model for the tetradic interpretation of the same scale. It is known that tetrads are fundamental for jazz music, and some classical objects for this kind of music are recovered.

- O. A. Agustín-Aquino and G. Mazzola, *Contrapuntal Aspects of the Mystic Chord and Scriabin's Piano Sonata No. 5*, https://arxiv.org/abs/1606.05833. Submitted for the conference Mathematics and Computation in Music 2019, to be held in Madrid, Spain, June 18-21, 2019. https://mcm19.etsisi.upm.es/

  **Abstract:** We present statistical evidence for the importance of the "mystic chord" in Scriabin's Piano Sonata No. 5, Op. 53, from a computational and mathematical counterpoint perspective. More specifically, we compute the effect sizes and $\chi^2$ tests with respect to the distributions of counterpoint symmetries in the Fuxian and mystic counterpoint worlds in two passages of the work, which provide evidence of a qualitative change between them.

- O. A. Agustín-Aquino and G. Mazzola, *A Projection-Oriented Mathematical Model for Second-Species Counterpoint*. https://arxiv.org/abs/1810.00306

**Abstract:** Drawing inspiration from both the classical Guerino Mazzola's symmetry-based model for first-species counterpoint (one note against one note) and Johann Joseph Fux's "Gradus ad Parnassum", we propose an extension for second-species (two notes against one note).

- O. A. Agustín-Aquino and J. S. Arias, A *Categorical Generalization of Counterpoint*. https://arxiv.org/abs/1810.00312

**Abstract:** We extend Mazzola's counterpoint model in terms of category theory. One immediate outcome is the possibility of relaxing the ``yes/no'' character of the definitions of consonance, and stressing its dependence on context in general. A counterpoint model with sets instead of pure pitches is obtained.

During my visit I delivered the talk "Pattern inventory polynomials for consonances and dissonances" in the University of Minnesota Combinatorics Seminar, and I had the opportunity to be referred to relevant literature concerning dihedral sieving and the enumeration of patterns with a specific group of automorphisms by Gregg Musiker and Dennis White, respectively.

**2. Students and post-doctoral fellows advised:** None.

**3. Including a summary statement (1-2 sentences) of major outcome of research visit:**

Mazzola's model for harmony was extended to tetradic harmony, in such a way that now explains the importance of certain scales, chords and progressions in jazz. The counterpoint model was extended to handle dissonances, resolutions and preparations, and it was proven to be present in one of Alexander Scriabin's compositions. There is a working model for second species counterpoint that has passed some tests of relevance for actual musical theories. Working jointly with J. S. Arias from Colombia via the internet and under supervision of Guerino Mazzola, we succeeded in building a first approximation of a general categorical model for counterpoint.

**4. Planned follow up activities and future implications (2-3 sentences)**

We expect the paper submitted to the conference Mathematics and Computation in Music 2019, to be held in Madrid, Spain, June 18-21, 2019, to be accepted, and thus I will report the results there. I also plan to submit the papers on second-species counterpoint and the categorical extensions to the Journal of Music and Mathematics and Compositionality, respectively, but before we will perform more statistical analysis and composition experiments that provide further weight to the relevance of the models.

Date: September 30th, 2018            Signature

Designation: Visiting Scholar