

## **Bridging Theater and Mathematics: a Mathematician's View**

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### **Abstract**

The goal of this paper is to explore the possibility of connecting mathematics and theatre by using mathematical objects or proofs to structure the plays, or by using theatre methods to illustrate mathematical notions, or both. The paper grew from the collaboration of the author with Dr. David White of Theatre Department. The paper describes this collaboration and offers thoughts on further steps.

### **Introduction**

Similar to many mathematicians, I had frequently found myself wishing that there was some way to communicate the beauty of mathematical ideas to the “uninitiated”. Such thoughts were amplified when I attended several of the “Saturday Science” talks organized by Hackerman Academy at Towson University. The well-attended by the community talks by scientists are intended for school-aged children. There are talks about astronomy, biology, chemistry, geology, physics and other science fields. Unfortunately, for the most part, mathematics is missing from the schedule of the talks: it seems to be difficult to keep the audience engaged. One of my motivations for this project is to find a way to communicate the joy of mathematical discovery by *leading* the audience through the process, rather than by telling the audience about the discovery.

This paper is the result of collaboration with Dr. David White of Theatre Department at Towson University. In fact, we first started to write a single joint paper, before realizing that, even though our goals agree, the motivations are too different to logically fit into the same article. An analogy that comes to mind is that of building a (physical) bridge: both sides work toward a common objective, but the direction of work is very different. The “other side” of the project is contained in paper [1] by David White, and should be read together with this paper.

David and I collaborated on several projects. I advised David about mathematical concepts involved in the play “Arithmetic Insurrection” he wrote for a mathematics education program at Towson University. I was a guest on the last three playwright laboratory workshops, WordBRIDGE. Interaction with David and other playwrights and dramaturgs contributed to a growing sense that there are (yet unexplored) connections between playwriting and (at least some) mathematical objects. It would be interesting to identify such connections in a systematic way. In [1], David White seeks to explain what a playwright means by the “structure of a play”. Is it possible to have a (non-trivial, interesting) mathematical object that describes such a structure? This paper offers first (and modest) steps towards finding an answer.

The experience of an audience member watching a play is frequently called a “journey”. It appears that at least a part of what keeps an audience member engaged with a play is the desire to find out what happens, or why something happens; keeping the audience interested in this discovery is what theatre has done for many centuries. It is exciting to think that this rich tradition can be used to motivate school students to study “real mathematics”; go beyond calculators and algebraic manipulations to joy of understanding why and how mathematics works.

### Mathematics in Plays

This section is structured according to my experiences with the play “Arithmetic Insurrection”, experiences at WordBRIDGE, and recent conversations with David White.

**“Arithmetic Insurrection”.** The play brought together the subjects of statistical study design, Archimedes eureka moment, Galileo’s discovery, and the story of Sophie Germain. The play was designed for middle school students with the hope that the information presented would be both entertaining and informative. Various mathematical objects, from tangents (both literary and mathematical) to Fermat’s Last Theorem were incorporated along with comedic structures presenting various kinds of information from basic science and mathematics to advanced concepts in a way that would make students laugh and think. One of the comedic structures used in “Arithmetic Insurrection” as well as many other plays is “The Rule of Threes.” At its most basic level this rule is stated as “things are funnier when they happen in threes.” The reasoning behind this is that a series of three events creates tension, builds tension, and then releases tension. Mathematically, this does not seem surprising: 3 is the smallest number of events for which a pattern can be first established and then broken or confirmed. Two similar events appear to set up a pattern, a subconscious expectation for the third event. The audience is rewarded when the third event is introduced and a pattern is either confirmed or changed in some way. Now, would it be possible to use a mathematical object as a play’s foundation? That is, the goal is to explore the “behind-the-scene” mathematics of plays rather than mathematics as the subject of plays.

**Mathematical objects as allegories.** Probably one of the most famous “dramatizations” of a mathematical idea is Bertrand Russell’s “barber’s paradox”. It offers a clear illustration of the idea behind the mathematical paradox, yet is stated in completely non-mathematical terms.

Is it possible to offer a similarly non-mathematical meaning for other mathematical constructions? One such possibility came up when I was talking to a playwright whose play was developed at WordBRIDGE. The subject of our conversation was the point at infinity (I described the “one-dimensional” version of a Riemann sphere). The playwright found it interesting and stimulating that the far extremes can be “close”, if one looks at them the right way. Some examples of the “close extremes” are crying and laughing; and mania and depression.

**Mathematical objects as play “backbones”.** In [1], David White describes the concept of the structure of a play from the point of view of a playwright. Recently, we had several conversations in which I attempted to offer some mathematical objects as candidates for such structure. One of these ideas, the group  $S_3$ , was received better than the rest. From a playwright’s point of view, permutations provide a way to show a switching of alliances when characters are assigned (and re-assigned) to each of the three “positions”. Can a proof serve as a structure of a play? We are exploring is whether the proof of irrationality of the square root of 2 by the method of infinite descent can be “converted” into a play structure.

### References

[1] David White, *Bridging Theatre and Mathematics: a Playwright’s View*. This volume.