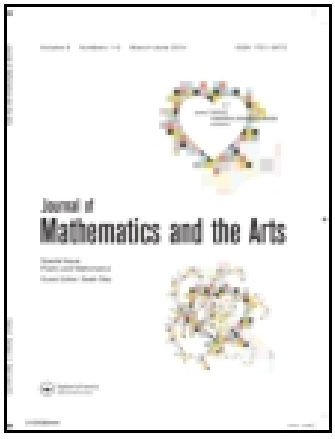

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Guest editor's introduction

Sarah Glaz[a]
[a] Department of Mathematics, University of Connecticut, Storrs, CT, USA
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Guest editor's introduction

Sarah Glaz*

Department of Mathematics, University of Connecticut, Storrs, CT, USA

Welcome to the special issue of the *Journal of Mathematics and the Arts* dedicated to the connections between poetry and mathematics. It is my hope that the 10 articles included in this issue, highlighting various links between the two disciplines, will provide both food for thought and hours of pleasurable reading.

In many ways a special issue dedicated to this topic is a thoroughly modern enterprise. Mathematics made possible all the recent advances in technology that shape our world today; its influence is felt in every aspect of our daily lives. Poetry is just as important in ways that are more difficult to describe, yet clearly its existence is essential to our well-being. In the words of the eminent poet Adrianne Rich [19]:

> Yet in fact, throughout the world, transfusions of poetic language can and do quite literally keep bodies and souls together – and more.

The major ways in which these two disciplines affect our lives provide a strong incentive for exploring, and even forging, new connections between them. Since the reprinting of Scott Buchanan's classic, *Poetry and Mathematics*, in 1975 [5], a growing number of books and poetry anthologies highlighting these connections began to see print [1,2,4,6,11–14,16,20,21]).

But this interest in the relations between mathematics and poetry is not a modern invention. It has a long history during which the two disciplines interrelated in a surprising variety of ways. Every historical era and every culture grappled with its own assessment of the closeness or distance, of the connection or separation, between the two disciplines. In this introduction I will discuss briefly three historical periods in which mathematics and poetry were perceived, like today, as informing and benefiting each other. The connections between the two disciplines that are revealed through the poetry of these times are precursors to those occurring today.

The first period of history goes back to the invention of the basic tools of both disciplines – letters and numbers. Writing, in the form of cuneiform figures for letters and numbers, was invented circa 3200 BCE in Mesopotamia, an ancient hub of civilization situated in the region of present day Iraq. The mathematical and poetic gifts left to us by the ancient civilizations that succeeded each other in the region from 4000 BCE to about the second century BCE seem to be intertwined. Below is my translation of a small sample from the poetry of that period that mentions mathematics: a fragment from a hymn dedicated to Nisaba, the grain goddess and patron of scribal arts and mathematical calculations.

> The true woman of unsurpassed wisdom
> consults a tablet of lapis lazuli, she
> dispenses council to all lands.
> The true woman measures the heavens, she
> stretches the measuring-cord on the earth.
> Nisaba, be praised!

The author of this hymn is Enheduanna, chief priestess of the moon god Nanna and daughter of the Akkadian king Sargon – who reigned over the region from 2334 to 2279 BC. Transliterations and translations of the temple hymns of Enheduanna appear in several sources (see, for example, the Oxford University archives of Sumerian literature, ETCSL [3]). In this hymn fragment, Enheduanna mentions her duties as chief priestess, two of which are mathematical: 'stretches the measuring-cord on the earth' refers to the geometer's job of calculating areas and exact boundaries of landed properties; 'measures the heavens' refers to her activities involving astronomical and calendrical calculations to determine religious holidays, auspicious times for important events, and seasonal civic and agricultural activities. On one hand, extreme practicality; on the other, touching the mysteries of the heavens above – although modern mathematics is considerably wider in scope, it possesses this dual character to this day. Enheduanna's poem fragment holds a mirror to what mathematics meant for the people of that time period. It also depicts the mathematicians of the day and suggests what

* Email: Sarah.Glaz@uconn.edu

their job was. It portrays mathematics as an important activity, one worth mentioning, perhaps even bragging about, in a religious hymn – an activity that was not separate from hymn writing or from spiritual duties and observances. For us, far removed from that time period, this poetry may be used to understand the origins of mathematics in its social and cultural context. It is essentially poetry in the service of mathematics. Additional mathematical poetry in historical context may be found in an earlier article in this journal [10].

The second period of history I would like to mention is the Middle Ages in India with its cultural tradition of recording mathematical results and problems in verse. Some of the most charming mathematical poems come from this tradition. For example, Bhaskara (1114–1185), the best known of medieval Indian mathematicians, wrote an algebra book believed to be intended for the education of his daughter, Lilavati. The book's title is also *Lilavati* (meaning 'the beautiful'), and it was written entirely in verse. The several translations of *Lilavati* into English in existence are in prose (see, for example, Colebrooke [7]), although a few of the poems were translated into verse in other sources. Below is my translation of a poem from *Lilavati*:

> Ten times the square root of a flock
> of geese, seeing the clouds collect,
> flew towards lake *Mánasa,* one-eighth
> took off for the S*thalapadminí* forest.
> But unconcerned, three couples frolicked
> in the water amongst a multitude of
> lotus flowers. Please tell, sweet girl,
> how many geese were in the flock.

The poems of *Lilavati* began a trend in mathematics education which is in practice to this day – the use of poetry as a pedagogical tool. Generally acknowledged is the fact that art can enrich the teaching of mathematics by strengthening students' engagement with the material. The power of a poem to engage and charm may lie in the response to the contrast between the abstract and impersonal mathematical idea, and the emotional and aesthetic nature of the poem associated with the idea. The power may also reside in the heightened interest generated by a presentation of mathematical ideas in a broad context, a context that includes cultural and artistic, as well as mathematical, dimensions. In addition to enrichment of pedagogy through engagement, poetry has been used in the mathematics classroom to shape course content and to enhance learning, retention and integration of material. Once again, we encounter a type of poetry whose goal is to serve mathematics – in this instance the service is pedagogical. A more detailed discussion and further resources for the uses of poetry in the mathematics classroom may be found, for example, in my paper [9].

Several hundred years later we arrive at the third period of history I would like to include in this discussion – mid-twentieth-century France – by which time mathematics had been transformed into the discipline we know today. It developed its own language; many of the basic mathematical symbols in use today were invented in Europe between the fourteenth and the seventeenth centuries [17]. The seventeenth century saw the development of calculus with its theorems and techniques for analysing motion and change. From the nineteenth century onward more rigorous approaches to mathematical demonstrations and increasing abstraction began to characterize the discipline. Mathematics had come to maturity, and by 1960 the time was ripe for using its language and concepts to contribute to poetry something more substantial than interesting geometric imagery. In 1960, Raymond Queneau and François Le Lionnais founded *Oulipo* (*Ouvroir de Littérature Potentielle* translated as 'Workshop of Potential Literature') – a literary movement whose purpose was to create literary works using constrained writing. Oulipo has become an international movement whose members (originally all French) are mainly writers interested in mathematics and mathematicians interested in literature. Many of the constraints invented by Oulipo are mathematical. A classic example of a poetic work that came out of the Oulipo movement is *Cent mille milliards de poèmes* by Raymond Queneau [18]. *Cent mille milliards de poèmes* (One hundred thousand billion poems) is what we call nowadays a combinatorics sonnet (Figure 1). It consists of a collection of 10 sonnets (14 lines each), which were originally printed on paper: one sonnet per page, with each line on a separate strip. All 10 sonnets not only have the same rhyming scheme, but also the same set of rhyming sounds, and so each line from one sonnet can be combined with any line from any of the other nine sonnets generating a total of 10^{14} different sonnets. Several translations into English and electronic versions of this poem are available online (see, for example, Douglass [8]).

In addition to combinatorial arrangements, many other mathematical patterns and algorithms, both abstract and visual, were used by the Oulipo literary movement to determine structure of poems. Their work continues to this day.

The connections between poetry and mathematics explored in the 10 articles of this special issue of the *Journal of Mathematics and the Arts* reflect contemporary culture and current mathematical progress and views on poetry. Nevertheless, they all owe a debt to the past when the seeds of what is possible today were sown.

Many of the articles mention historical aspects, but three of them in particular make history a major part of their discussion. Alla Shmukler and Clara Ziskin's article provides a substantial list of creative mathematicians who wrote poetry from antiquity till the middle of the twentieth century, along with brief descriptions of their mathematical and poetic achievements. Arielle Saiber's article focuses on one of the major advances in mathematics during the Italian renaissance – Tartaglia's solution of the cubic equation – and

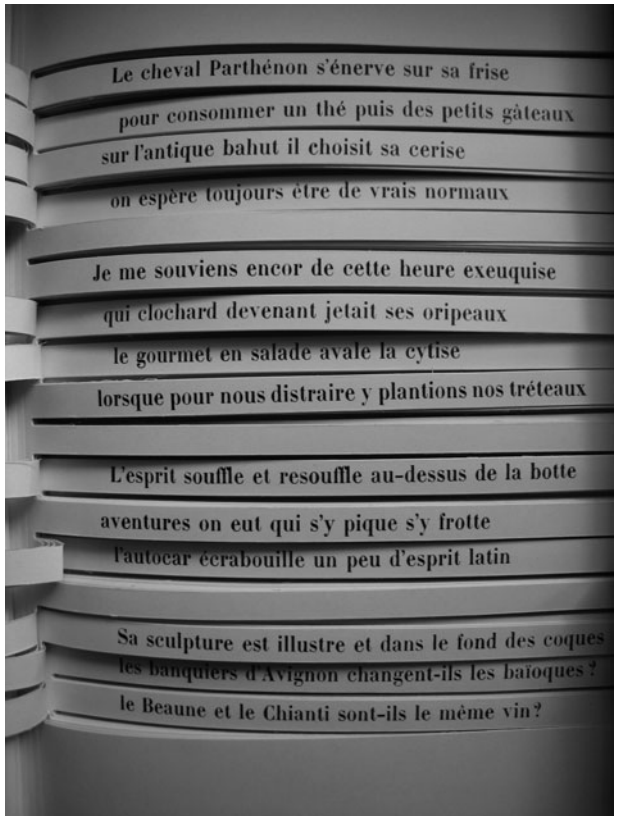

Figure 1. *Cent mille milliards de poèmes* by Raymond Queneau [15].

discusses the cultural, literary and personal implications of his decision to embed his discovery in a poem. Gizem Karaali's article touches on the personal journey that allowed her to combine her interests in mathematics and poetry, as well as on the recent history that led to the creation of a growing number of blogs, journals, organizations and conferences that revolve around the connections between the two disciplines.

The spiritual and mystical connection between mathematics and poetry revealed in the hymn of Enheduanna has a contemporary counterpart in the exploration of philosophical connections between the two disciplines. Although several other of the articles touch lightly on philosophical issues, three of them make this their major theme. Ron Aharoni's article grapples with the age-old question 'what is beauty?' and inquires why the beauty of mathematics resembles the beauty of poetry. In particular, the article explores two common techniques that generate beauty in both disciplines. Emily Grosholz's article provides a philosophical analysis of the concept of 'the circle' in mathematics and poetry through the examination of the work of some of the greatest practitioners in both disciplines. In the process, the article reveals both similarities and differences in what 'a search for conditions of intelligibility' means in the two disciplines. Alice Major's article examines five paradoxes that intrigued both artists and mathematicians throughout the recorded history of human thought. Exploration of their mathematical meaning is followed by their 'translation' into the language of poetry by the author.

The pedagogical connections between poetry and mathematics, which were initiated in the poetry of medieval India, make an appearance in three of the articles of this issue. Larry Lesser's article explores various types of song lyrics that are connected to, or were inspired by, mathematics or statistics, and their role in the mathematics classroom. The article discusses strategies for creating such lyrics as well as for using them in an educational setting. Gizem Karaali's article devotes a section to her experiments with poetry in mathematics classes; and Dan May's article briefly discusses possible applications for the graph theory techniques appearing in his article to teaching both mathematics and poetry courses.

The legacy of Oulipo is felt in several of the works included in this issue. In particular, two of the articles discuss types of poetry – electronic poetry and visiomathematical poetry – that are direct descendants of Oulipo practices, while a third article uses mathematics in Oulipo-like fashion to search for patterns in the quatrains of the *Rubáiyát.* Jeremy Douglass' article explores the ways that numerical, mathematical and algorithmic thinking provide insight into the designs of works of electronic poetry, and suggest interpretative strategies for understanding such poems. Bob Grumman's article discusses the use of metaphor in poetry that employs more than one 'language' besides words, such as visual images or mathematical expressions. Along the way, the article offers suggestions on how to read poems that are strongly visual and mathematical. Dan May's article considers a way of utilizing graph theory concepts, such as complete graphs, to explore the connections between the various quatrains contained in FitzGerald's translation of Omar Khayyám's *Rubáiyát*, and discusses how these ideas may be relevant to other areas.

I would like to express my heartfelt gratitude to all those who have helped bring this issue to a successful completion. I thank all the authors for their lovely and lively contributions, and the numerous referees – who shall remain anonymous – for their conscientious reviewing and helpful suggestions. I thank Craig Kaplan (editor in chief of the *Journal of Mathematics and the Arts*) and the Taylor & Francis team, Helen Gray, Suzanne Sherratt and Daniel Hartley, for their generous support and help with the preparation and production of this issue. Special thanks go to Emily Grosholz and Alice Major for friendly and useful input on my own writing, and to my husband, Joe Glaz, for his loving and continuous encouragement. Thanks are also due to Sarah Hertz for permission to use her photograph of Raymond Queneau's *Cent mille milliards de poèmes*, and to *The Guardian*, for the cited excerpt from Adrianne Rich's *Commentary: Legislators of the World*.

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