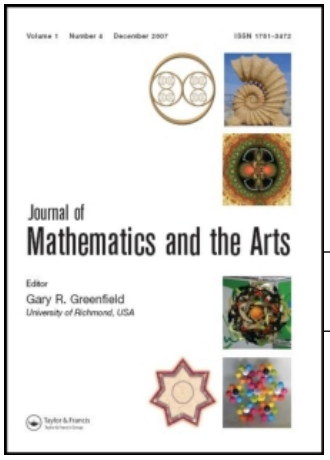

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Mathematics influences poetry

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In the early 1990s I began to gather examples of poetry with mathematical imagery to enrich my mathematics classes at Bloomsburg University. Both poetry and mathematics employ concentrated language, stating with concise elegance more than is first apparent. Gradually I became a writer of poems and, within this activity, have looked for mathematical influences on the structure of poetry. Drawing on examples from these past explorations, I develop and illustrate these points: (1) mathematics and poetry demand similar creativities; (2) constraints involving mathematics give poets the opportunity to discover new language; (3) mathematics offers precise and vivid imagery for poems.

Keywords: mathematical poetry; OULIPO; sestina; square poem

1. Introduction

What is *mathematical* about poetry? Are they not near-opposites? As a mathematician who writes poems, I am not surprised to discover similarities between mathematics and poetry. In this paper, I explore some of those likenesses and describe ways that I see mathematics influencing poetry.

2. Poetry and mathematics as *arts*

When acquaintances first learn of my strong interests in both mathematics and poetry, they react with surprise – and offer some sort of comment about my engagement with both left- and right-brain activity. To me, however, writing poetry and writing mathematics seem similar. Each composer – whether poet or mathematician – seeks precision and concise clarity in language. Words are weighed and sifted until each remaining linguistic unit contributes maximally. The poet carefully considers each word – its sensory and emotive qualities, its sounds, its length, its location on the page. Like mathematicians, innovators in both symbol and form, poets seem to create meaning out of thin air.

Whether we are mathematicians or poets, it is the case that many of our associates hold themselves aloof from our beloved subject. In this vein, consider the following statement, and ask yourself if you might replace the blank with 'mathematics'?

> I think that one possible definition of our modern culture is that it is one in which nine-tenths of our intellectuals can't read any _____.

Poet Randall Jarrell (1914–1965) made the statement [24, p. 391] using 'poetry', but 'mathematics' fits as well. Jarrell was Poetry Consultant to the Library of Congress from 1956 to 1958 and often spoke out about the weak or missing attempts of American readers to tackle good poetry. Indeed, it is a puzzling disappointment to mathematicians and poets alike that many people proclaim central and essential value for poetry, or for mathematics, while also avoiding them assiduously. Is it the careful nature of our craft that sets it (and us) apart?

What is *mathematics*? What is *poetry*? Each is multi-faceted and, for me, nearly impossible to define – but both involve 'language' and 'imagination', 'elegance' and 'delight'. Howard Nemerov (1920–1991), Poet Laureate of the United States from 1988 to 1990, said: 'Poetry is getting something right in language' [23, p. 55]. Nobel Prize winner (1948) T.S. Eliot (1888–1956) said: 'Genuine poetry can communicate before it is understood' [8, p. 238]. Although dictionaries pin down 'mathematics' with relative ease using a description like 'a science dealing with the logic of quantity, shape, and arrangement', mathematicians do not agree so easily.

Well known to mathematicians as 'one of us', Bertrand Russell (1872–1970) who was, like Eliot, a winner of the Nobel Prize in Literature (1950), offered this: 'The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry' [21, p. 182]; and, from mathematician Karl Weierstrass (1815–1897), we have: 'It is true

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that a mathematician, who is not somewhat of a poet, will never be a perfect mathematician' [21, p. 121]. Weierstrass affirms that the excellent mathematician takes as much care with language as the poet does. For either and for both, the language should include what is essential, avoid what is unnecessary, and evidence the best way of saying what is said.

An interested mathematical reader might, at this point, take up this challenge: what are examples of fine poetry within mathematics? Is Euclid's proof of the infinitude of primes poetic? What about the Pythagorean Theorem or the equation that asserts that the sum of all negative powers of 2 is equal to 1? One of my own selections is the *Pigeonhole Principle* – a statement that, like a mantra, and like a good poem, takes on new meaning again and again: *if the number of pigeons residing in your pigeon house is more than the number of pigeonholes, then at least one pigeonhole must have more than one pigeon*.

3. Counting is the *backbone* of poetry

In our school years we were introduced to particular forms in poetry – perhaps including both sonnets and limericks. From these introductions we know that counting may be important in poetry. In a sonnet one counts 14 lines; in a limerick, five lines. Each sonnet line contains (though occasional exceptions may improve the rule) 10 syllables in five pairs. Each pair contains an unstressed syllable followed by a stressed one as in 'to-DAY'. A limerick consists of five lines of which lines 1, 2, and 5 each have three stressed syllables and end with words that rhyme; likewise lines 3 and 4 each have two stressed syllables and end in rhyming words.

Limericks are nearly always amusing and often bawdy. There are numerous online sources of limericks with mathematical content found easily by searching the internet using keywords *mathematical limerick*. Here is a well-known example by artist John Ward McClellan (1908–1986), popularized by his friend and colleague Martin Gardner [17].

> A lady of 80 named Gertie
> Had a boyfriend of 60 named Bertie.
> She told him emphatically
> That viewed mathematically
> By modulo 50 she's 30.

These final lines of a sonnet by Edna St. Vincent Millay (1892–1950) speak of the austere beauty of mathematics [18, p. 45]:

> ... Euclid alone
> Has looked on Beauty bare. Fortunate they
> Who, though once only and then but far away,
> Have heard her massive sandal set on Stone.

Elizabeth Barrett Browning (1806–1861) invoked mathematical imagery as she began 'Sonnet XLIII' of *Sonnets from the Portuguese* [5, p. 54]:

> How do I love thee? Let me count the ways.
> I love thee to the depth and breadth and height
> My soul can reach ...

Although it can seem elementary and tedious to emphasize the role of *counting* in the construction of poems, it is important to realize that the emotional punch of a poem, as in a piece of music, is dependent in part on this mundane factor. We observe, for example, that Millay's line 'Who, though once only and then but far away', has 11 syllables rather than 10 and varies from the pattern of alternating stressed and unstressed syllables. This variety draws the poem toward natural speech. In a sonnet and other fixed poetic forms, the pairing of our expectations concerning the rhythms of natural speech with the imposed rhythms established by the form of the poem causes tensions that heighten the reading experience. In short, counting is an attentiveness to detail that contrives to heighten reader involvement in a poem – which would not be as great if the poet had not scrupulously counted: counted the number of lines per stanza, the number of words per line, the number of syllables per line. The arrangement of accented or stressed syllables, the numbers of syllables per word – these, too, contribute to the impact felt by the reader of a poem. A poet who has written many sonnets – as, for example, Shakespeare or Millay or, in modern times, Vikram Seth, whose entire novel, *The Golden Gate* [28], is presented in a sequence of sonnets – develops an internal and subconscious number-sense like that of a musician or a mathematician.

A French poet and member of the OULIPO group, which is described below, developed sonnets that he called *irrational*. Jacques Bens (1931–2001) took the digits of the decimal expansion for π, 3.14159265 ... and observed that the first five of these digits sum to 14. And so Bens wrote his *irrational sonnets* with stanzas of these lengths: three lines, one line, four lines, one line, and five lines. An English translation, by Laurence Petit and Ravi Shankar, of one of his irrational sonnets, 'The Presbytery Has Lost None of Its Charm' is included, along with detail of the sonnet's 'masculine' and 'feminine' rhymes, in the online journal, *The Drunken Boat*, 2006 [4]. Here are the initial lines of the English version of Bens' sonnet.

The Presbytery Has Lost None of Its Charm …

The presbytery has lost none of its charm
Nor how a garden's radiance can disarm,
Restoring hand to dog, and bridle to stallion:

But this explanation fails this mystery.

A plague on insight that cracks your talons,
The analysis that dispels your sense of alarm,
Wearing a preposterous cop's cap for a perm,
Pointing out here the just and there the felon.

4. Shape of a poem

Geometric figures such as a triangle or square can provide structure for a poem. At UbuWeb [14] we find a photo of an early (1597) *square* poem by Henry Lok (1553–1608) – a 10-line poem with 10 syllables in each line entitled 'Square Poem in Honor of Elizabeth I'. Formal constraints concerning the shape of a poem prod the poet to exceptional care in word choice. There is not space for an extra syllable. Meaning must be condensed.

Here are two small poems of mine that are square – with the number of syllables per line the same as the number of lines [10]:

When lovers leave,
avoid laments—
grab a cactus:
new pain forgets.

More than the rapist, fear
the district attorney,
smiling for the camera,
saying that thirty-six
sex crimes per year is a
manageable number.

If we accept the line as the basic unit of poetry and treat all lines in a poem with equal weight, this affects our design of a poem. Any word that has its own line has been given great importance. Likewise in a long line, all parts contribute to one whole. In this light, consider then my triangular poem, 'More than Counting' [11], in which each line has one syllable more than the preceding:

More than Counting

One
added
forever,
joined by zero,
paired to opposites –
these build the integers,
base for construction of more
new numbers from old: ratios,
radical roots and transcendentals,
transfinite cardinals – conceptions bold!

If you read 'More than Counting' aloud, using a slight pause as the aural equivalent of eye-movement to the next line, you will notice how the poem starts slowly and picks up pace.

The American poet Marianne Moore (1887–1972) studied biology when she was an undergraduate at Bryn Mawr. Syllable-count was a vital structural component in her verse. She did not, however, make her lines uniform in length but instead repeated a stanza pattern of her own devising. Consider, for example the final pair of stanzas from her poem [20, p 33], 'The Fish'.

ac	1 syllable
cident—lack	3 syllables
of cornice, dynamite grooves, burns, and	9
hatchet strokes, these things stand	6
out on it; the chasm is	7
dead.	1
Repeated	3
evidence has proved that it can live	9
on what can not revive	6
its youth. The sea grows old in it.	8 syllables

5. Mathematical processes contribute originality to poems

New York sculptor Carl Andre has written work that follows the tradition of 'Concrete Poetry', displaying words on a page as if they were drawings. One of his poems, 'On the Sadness' [3], has its structure based on the Fundamental Theorem of Arithmetic. The lines of Andre's poem correspond to the integers counting backward from 47 to two. A new statement is introduced for each prime; for multiplication the connector 'if' is substituted, and 'then' corresponds to exponentiation – so that statements for composite integers may be constructed from those for primes. The structure imposed by factorization is illustrated by these final seven lines of Andre's poem:

We are going to die then the sky is blue	$8 = 2^3$
Men grow old	7
We are going to die if the sky is blue	$6 = 2 \times 3$
The grass is green	5
We are going to die then we are going to die	$4 = 2^2$
The sky is blue	3
We are going to die	2

A reader may now create additional lines of Andre's poem; for example, the third line, corresponding to the number 45, is:

The sky is blue then we are going to die if the grass is green	$45 = 3^2 \times 5$

A group of French intellectuals, the OULIPO (OUvoir de LItterature POtentielle/Workshop of Potential Literature), invented new ways to use mathematics in poetry [22]. The OULIPO was founded in 1960

by the French mathematician Francois Le Lionnaise (1901–1984) and by Raymond Queneau (1903–1976), a writer who also played with mathematics. Graph theorist Claude Berge was another one of the original members – all of whom were writers or mathematicians or both. OULIPO activities were introduced to Americans in the 1970s by *Scientific American*'s 'Mathematical Games' columnist, Martin Gardner, and his columns continue to serve as good introductions to the word-play activities of that group [9].

A popular OULIPO algorithm is called $S+7$ (for 'Substantif plus 7', in English $N+7$) and is a procedure that replaces each noun in a familiar passage (perhaps a poem) with the seventh noun that follows it in a specified dictionary. A follower of OULIPO applies mathematical or other algorithms to help the mind to escape the unconscious rules that stifle the new or creative.

For example, if I start with 'In a Station of the Metro' by Ezra Pound [25].

In a Station of the Metro

The apparition of these faces in the crowd;
Petals on a wet, black, bough.

and use my *Webster's New World Dictionary*, Third College Edition, 1988, application of the substitution $N+7$ gives

In a Statue of the Mew

The appellation of these factions in the crucible;
Petrels on a wet, black bounce.

Using my dictionary and applying the $N+7$ rule required me to make some arbitrary decisions along the way; for example, whether to skip proper nouns, whether to consider variants of a word as a single unit. In my application above, I skipped nouns offered only in plural when I needed singular. My choice of 'mew' was the third noun given for that spelling, the 'mew' meaning 'gull'.

This procedure may be extended to $N + k$ for any positive integer k; despite all of this possibility, I do not argue that such arbitrary substitution is likely to yield a good poem. For me it did not. But it has led me to some phrases I would not otherwise have thought of – and ones I rather like. The phrase 'factions in the crucible' seems full of meaning; it waits for me to discover how it applies. 'A wet, black bounce' brings to mind falling in the rain and not getting hurt – a new way of saying something – which is what we expect from a good poem. The OULIPO algorithms can free us of the limitations of being ourselves, with thoughts limited by our own learning and experiences. With an $N+7$ substitution I may create poems I could not otherwise conceive.

A well-known, amazing OULIPO creation is *Cent Mille Milliards de Poémes* (*One Hundred Thousand Million Poems*) by Queneau [26]. This 1961 collection of 10 sonnets had each sonnet published on a card cut into strips with each line on a separate strip of card – so that each first line from any sonnet might be combined with any second line from any sonnet and so on – and in the original French the sonnets all (10^{14}) use the same rhyme scheme and rhyme sounds.

Another mathematically interesting poetic form is the *sestina*. Dating back to troubadours of the 12th century, the sestina involves permutations; its 39 lines consist of six six-line stanzas, followed by a *tercet* or three-line stanza. The same set of six words ends the lines of each of the six-line stanzas, but in a different order each time; these six words then appear, two per line, in the final tercet. Sestinas in English often are written in iambic pentameter, the line pattern also of the sonnet. (It has been said that the 10-syllable iambic pentameter line with its five stresses, 'da-DUM-da-DUM-da-DUM-da-DUM-da-DUM', is the 'natural' rhythm of all poetry: five heartbeats, one breath.)

Contemporary California poet and teacher Scott Reid has posted online [27] his poem, 'Sestina in the Computer Age'. The complete text of Reid's sestina is included as Appendix 2. Here are the first two stanzas:

A friend said I didn't need to know the UNIX
operating system to locate Czeslaw Milosz
reading his poetry on the World Wide Web,
so I turned on Netscape and began to surf
the Internet. My girlfriend thought I was a dweeb,
but I told her, *Honey, this really isn't a hoax*.

She thought it was a hoax	(from line 6 of stanza 1)
anyway as I sat in a dim room staring at a UNIX	(1)
prompt on my screen. Maybe I am a dweeb	(5)
after all for thinking Czeslaw Milosz	(2)
will appear on my terminal like surf	(4)
rocking in and out of sea shells and web	(3)

If we number the first stanza's lines 123456, then the end-words for the second stanza appear, as shown, in the order 615243; if these new lines are renamed 123456, a similar rearrangement will yield the third stanza, and so on: In Reid's sestina, for example, the final words for the six lines of the third stanza must be: web, hoax, surf, UNIX, Milosz, dweeb.

A reviewer of this paper was curious about the sestina and wondered, in particular, why we find many more sonnets than sestinas in our collections of poetry. For most of us who write poems, the form is difficult. A sonnet offers 14 lines: just enough space to put down for a small portrait or story or argument; it starts somewhere, goes somewhere else. But a sestina is constrained to move in a tight twist around six words – each stanza, the same six end-words – as if a fly is trying to dance with six feet stuck to flypaper.

6. Mathematics inside a poem

As illustrated in the preceding section, mathematical procedures such as permutation or substitution may help a writer to produce a poem that is beyond the stretch of ordinary imagination. On the other hand, it is also the case that poets who know mathematics may use its words and images to make their verses vivid. The most common short phrase for 'poems containing mathematical terminology and imagery' is 'mathematical poetry' – although this term is flawed: the poems contain terminology of maths without being literally 'mathematical'. Still, there seems not to be a better choice. For years I have collected examples of *mathematical poetry* and I complete this article with sample lines from several of my favourites. I hope that the reader will agree that these poems have some of the *spirit* of mathematics and will enjoy the use of the references that follow and my suggestions 'for further reading'. These poets use mathematical terms as painters use brushes – to give us the picture that is *worth a thousand words*.

I'm always dreaming
of a life between
the 3/16 that names me white
and the 13/16
that names me Indian.

from 'Reservation Mathematics' by Sherman Alexie [2]

... the world is all subtraction in the end

from 'Kismet III' by Diane Ackerman [1]

$$\text{love} = \lim_{\text{ego}\to 0} \frac{1}{\text{ego}}$$

'Sacrifice and Bliss' by Kaz Maslanka [16]

And I never fail to be surprised/by the gift of an odd remainder...

from 'Numbers' by Mary Cornish [6]

As lines, so loves oblique may well
Themselves in every angle greet;
But ours so truly parallel
Though infinite, can never meet.

from 'The Definition of Love' by Andrew Marvell (1621–1678) [15]

If, as in water stirred more circles be
Produced by one, love such additions take,
Those like so many spheres, but one heaven make,
For they are all concentric unto thee...

from 'Love's Growth' by John Donne (1572–1631) [7]

Making love we assume/may be defined by the equation/ for the hyperbola $y = 1/x$...

from 'Sex and Mathematics' by Jonathan Holden [13]

Dear son and daughter, if I seem to range
It is to chart the numbers spiraling
Between my life and yours until the strange
And seamless beauty of equations click
Solutions for the heart's arithmetic.

from 'An Equation for My Children' by Wilbur Mills [19]

And, finally, a poem of mine – written at national mathematics meetings a few years ago [12].

San Antonio, January, 1993

A mathematician left the convention
focused on 9, the digit that sits
in the billionth decimal place of pi,
ratio of circumference to width
of the yellow circle that parted the clouds
as she strolled down Commerce Street
to the Rio Rio Café for lunch and a beer.

On fire with jalapeños
she went shopping
for a souvenir.
She bought earrings –
red-red plastic peppers
with green stems.

She said, 'Hot peppers
are like mathematics —
with strong flavor
that takes over
what they enter.'

Acknowledgments

Thanks to Scott Reid who gave permission to include his 'Sestina in the Computer Age' http://sonic.net/~scotts/sestina.html (accessed January 2008). Thanks also to Gary Greenfield and Daylene Zielinski for their early encouragement of this paper and for their necessary and helpful editing

throughout, and to the anonymous reviewers for their useful comments.

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Appendix 1. For further reading…

We who inhabit the arena of 'mathematical poetry' are explorers rather than scholars – trying new things and suggesting them to others rather than pinning down all of the possibilities. In that spirit, here are several sources to investigate: essays that offer thoughtful consideration of mathematical poetry and collections of poems with mathematical structure or imagery. And, beyond the works cited, search engines on the Internet respond generously when 'mathematics' and 'poetry' are offered as search terms.

Against Infinity: An Anthology of Contemporary Mathematical Poetry, edited by Ernest Robson and Jet Wimp. Primary Press, Parker Ford, PA, 1979.

Cent Mille Milliards de Poémes; by Raymond Queneau; an interactive English Translation by Beverly Charles Rowe is available at http://www.bevrowe.info/Queneau/QueneauHome_v2.html (accessed January 2008); a click on the upper-left-hand link, 'See the Poems', enables an explorer to create variations of the sonnets.

Crossing the Equal Sign by Marion Deutsche Cohen, Plainview Press, Austin, Texas 2006.

Imagination's Other Place: Poems of Science and Mathematics, edited by Helen Plotz. Thomas Y. Crowell, New York, 1955.

Mathematics as a Culture Clue and other essays, by Cassius Keyser. Scripta Mathematica, 1947.

Memorabilia Mathematica, Robert E. Moritz, ed., Macmillan, 1914. Re-issued in 1993 by the MAA along with a companion volume, *Out of the Mouths of Mathematicians* by Rosemary Schmalz. Moritz' collection includes verse by Dante, DeMorgan, Goethe, and Wordsworth.

My Dance is Mathematics by JoAnne Growney. Paper Kite Press, Kingston, PA, 2006; available from the poet, http://joannegrowney.com (accessed January 2008) or japoet@msn.com

Numbers and Faces: A Collection of Poems with Mathematical Imagery, ed. JoAnne Growney, Humanistic Mathematics Network, 2001. Out of print; electronic version available from the editor, japoet@msn.com

OULIPO: A Primer of Potential Literature, Warren F. Motte, Jr., translator and editor. Dalkey Archive Press, Normal, IL, 1998. This collection of essays is a classic introduction to the people and ways of *OULIPO*.

Penrose Tiles to Trapdoor Ciphers, Martin Gardner. Freeman, 1989. Chapters 5 and 6 introduce the *OULIPO*.

Strange Attractors: Poems of Love and Mathematics, edited by Sarah Glaz and JoAnne Growney. A. K. Peters Ltd, Wellesley, MA, 2008. Poems in this collection speak mathematically and poetically of love in its many varieties – love of family, romantic love, spiritual love and, finally, love of mathematicians and mathematics. Available October 2008.

Poetry and Mathematics, by Scott Buchanan. J. B. Lippincott, Philadelphia, 1962. First published in 1929, this book is dedicated to Dante and to Kepler – to the poet who was a mathematician and to the mathematician who was a poet.

Sestinas: an online collection: http://www.mcsweeneys.net/links/sestinas/(accessed January 2008).

The Drunken Boat – this e-zine contains the irrational sonnet by Jacques Bens, 'The Presbytery Has Lost None of Its Charm...' in the 2006 issue (click on OULIPO, then on Benz) and is a fine source of many ideas and examples of literature following OULIPO patterns or traditions. http://www.drunkenboat.com/db8/index.html (Accessed January 2008).

Much mathematical poetry is available through the Internet, including sites maintained by these mathematical poets or songwriters: Marion Cohen, Jonathan Colton, JoAnne Growney, Tom Lehrer, Kaz Maslanka, and Katherine Stange. British singer Kate Bush has written a song-lyric entitled *PI* – lyrics are available online. Search engines will locate the up-to-date URLs for each.

Appendix 2. Full text of Scott Reid's 'Sestina in the Computer Age'

A friend said I didn't need to know the UNIX
operating system to locate Czeslaw Milosz
reading his poetry on the World Wide Web,
so I turned on Netscape and began to surf
the Internet. My girlfriend thought I was a dweeb,
but I told her, *Honey, this really isn't a hoax*.

She thought it was a hoax
anyway as I sat in a dim room staring at a UNIX
prompt on my screen. Maybe I am a dweeb
after all for thinking Czeslaw Milosz
will appear on my terminal like surf
rocking in and out of sea shells and web.

The NET? The WEB?
All these terms must sound like an abusive hoax
to someone who respects language and surfs
the ocean instead of filling his head with UNIX,
someone like Nobel Laureate Milosz
who probably thinks this computer stuff is for dweebs.

But after hours and hours of dweebing
around on the Internet and searching the Web,
I located the audio recording of Milosz
reading his poetry. It wasn't a hoax
after all. Maybe I should take a UNIX
class this summer, where I could really learn to surf.

Then my girlfriend wanted to surf
the Internet too and become a dweeb
like me. I told her that UNIX
is like pure language, not a tangled web
of rhythm and sound like poetry. The real hoax
came when I learned that the great poet Milosz

had been surfing all along. Imagine! Milosz
the magnificent and his following of surfers
holding that pure language is a hoax,
and that some day, the rest of us will join his cult of dweebs
and follow them online to sites on the World Wide Web
where we would be highly regarded as eunuchs.

I had been a dweeb all along, thinking that Milosz
didn't know UNIX. He was a veteran surfin' dude
who knew all the hoaxes that one encounters on the Web.