

Two New Combinatoric Poetry Forms: Braided Bellringing PH4 Poems & Anagrammatic, Anglo Saxon- inspired Poems

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Abstract

This paper introduces, describes, exemplifies and tells the story of two new poetic forms based on permutations. Braided Bellringing PH4 poems use permutations at the level of words and phrases, while Anagrammatic, Anglo Saxon-inspired poems use permutations at the level of letters and spellings. The author discusses formal poetry in terms of an optimal balance between enabling constraints and creative freedom, and contextualizes rule-based mathematical poetry and wordplay. There is a discussion of opportunities for embodied, movement-based learning experiences supporting the development of mathematical understanding through collaborative performances of PH4 poems.

Poetic forms: Enabling Constraints

In poetry, as in all the arts, mathematics and other creative realms, the emergence of new works and ideas thrives on an optimal interaction between free play and what have been called ‘enabling constraints’. Davis, Sumara and Simmt write about enabling constraints as a core notion in complexity science, used to describe emergent phenomena: “The rule structures that enable complex systems maintain a delicate balance between sufficient randomness to allow for flexible and varied response and sufficient organization to channel such responses into coherent [collective] activity [2].”

In the realm of poetic forms, optimally constraining formal rules have the potential to generate surprising, sometimes delightful results that benefit from the interplay of imposed rules and restrictions, and imagination, openness, and a degree of randomness and chance. Some poetic forms are well established in literary tradition – for example, villanelles, triolets, haiku, Petrarchan and Shakespearean sonnets, limericks and others. New poetic forms have been invented by mathematician/ poets who take pleasure in the interactions of the constraints and freedoms of language and mathematical patterning as they are brought together in novel ways. Oulipo (the *Ouvroir de Littérature Potentielle* or ‘Potential Literature Workshop’), founded by French mathematicians Raymond Queneau and François Le Lionnais in 1960, devised many new forms of mathematical poetry, including $N+7$ and One Hundred Thousand Billion Sonnets, working in a transdisciplinary space spanning mathematics and literature [16]. Speaking of the importance of enabling constraints in this creative pursuit, Queneau defined Oulipian writers as “rats who build the labyrinth from which they plan to escape”, and Oulipo mathematician/ poet Georges Perec is quoted as saying “I set myself rules in order to be totally free”[5]. I recently learned that others working in the Oulipo tradition have also been ‘anagrammarians’, writing poetry with anagrams at the level of sentences, words and phrases [for example, 3, 18].

Many of the mathematical poets at Bridges have explored (and invented) poetic forms that have fascinating mathematical enabling constraints, including visual and geometric patterning; computational and stochastic modes of generation; logical, numerical, metaphoric and graph-theoretical rules, and others [for example, 8, 10, 13, 14, 15, 17]. With Sarah Glaz, I intend to “be inclusive and call a poem mathematical if it has a significant mathematical component of any kind” [8], rather than engage in debate about what

counts as a truly mathematical poem. Mathematics and poetry have great breadth and depth, and allow for many fruitful interactions.

Two new combinatoric poetic forms

The two forms described and exemplified here work with permutations on two levels of language: the first on the level of words (or short phrases), and the second on the level of orthography/spelling. *Braided Bellringing PH4 poems* developed from a workshop taking a pleasing pattern from group theory and realizing it in a variety of artistic media, starting from musical bellringing, and extending to visual arts, culinary arts, and performative poetry integrated with dance and movement [7]. The second form, *Anagrammatic, Anglo Saxon-inspired poems*, emerged from the rules and results of a combinatoric/linguistic game brought together with inspiration from the formal rules of Old English poetry. I will tell the stories of the emergence of these new forms, describe their rules as they currently stand, and offer examples of both, and an analysis of what makes these forms work as poetry. I will also offer a rationale for working with *Braided Bellringing PH4 poems* as a form of embodied mathematical art at a large scale that promotes multisensory engagement and deeper understanding of its combinatoric form through movement.

Braided Bellringing PH4 poems

The braided permutation group pattern called the Plain Hunt comes from the practice of change ringing of tower bells or hand bells, originating in 18th century England and now a popular activity around the world. Bells controlled by individual participants are rung in rule-governed sequences that may be quite challenging to remember and execute correctly. Bellringing and permutations have been explored in several previous Bridges papers [1, 12, 19], including a workshop by the author and collaborators on realizing the PH4 permutation in a variety of media to promote understanding of group structure [7].

The Plain Hunt is a basic bellringing permutation where the ringing of any particular bell tracks diagonally across the sequence over time – a permutation that maps onto a simple multi-strand braiding pattern. The Plain Hunt on 4 (PH4) takes four initial symbols (or bells, or threads, or words) and swaps spots for the two end pairs and then the middle pair recursively, resulting in 8 distinct permutational patterns before the four initial symbols return to their starting positions (Figure 1). Since there are 4! or 24 possible permutations of four symbols, the PH4 selects a third of the all the possible permutations, and there are three distinct PH4 subgroups of the group of permutations on four symbols, dependent upon initial row order.

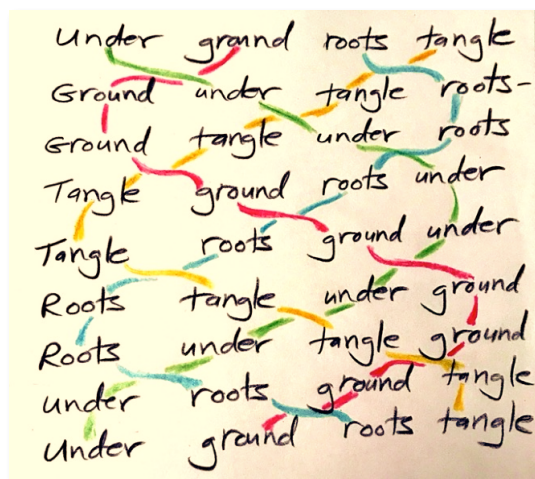


Figure 1: Diagram of 'swaps' in PH4 poem. Poem & illustration: S. Gerofsky

Since our initial exploration of PH4 poetry in [7], I have experimented with this poetic form in workshops in Canada and Germany, and report further here about the poetic affordances of this interesting permutational form.

Each PH4 poem (or stanza) requires the choice of an initial string of four words (or alternately, short phrases). Once those have been selected, the permutations are automatically generated by the PH4 algorithmic pattern, although the poet still has choices about punctuation and alternate spellings of homonyms or puns. In previous workshops, four participants have chosen a word, either collaboratively or individually, decided upon an initial order for the words by standing in a row (each with their word), and played out the PH4 poem by swapping places and reading their words aloud according to the bellringing algorithm [7]. In this more focused poetry writing, the individual writer is in charge of making lexical and ordinal choices with poetic intention. As with Lajeunesse’s Graeco-Roman Square poems [13], the initial word choices and word order are important – and working through the constraints of the permutational pattern, surprises and unexpected juxtapositions often emerge. With only four choices, words that can be interpreted in multiple ways or as multiple parts of speech (for example, words that can be treated as either a noun or a verb) often yield the most interesting results.

Metre and stress-unstress patterns of chosen words and phrases are also important factors in establishing the rhythms of the lines as the poem or stanza progresses through its permutations.

When choosing phrases rather than individual words, the poet has to make decisions about where to place phrase breaks to create particular moods and meanings. Different choices will play out as quite different poems, some more appealing than others.

The relentlessness of the PH4 eight-step “swapping” algorithm in itself gives a feeling of a mind running through many possibilities of the words in the initial line, refusing to let go of the words until all eight permutations have been spoken, and that may give the poem an obsessive and/or contemplative quality. It is certainly a mathematical quality as well, systematically working through the ordered permutations and hearing their qualities in the form of meaningful words, and enjoying the pleasure of the braiding sequence, as our hands might enjoy the process of braiding fibres. It can be interesting to choose a familiar or altered phrase or line of poetry (in a process similar to electronic sampling) and then to play it out through the PH4 changes.

Here is a new example of a multi-stanza poem (with apologies to Robert Frost) based on these processes, where each stanza has been composed using the *Braided Bellringing PH4* form. (Several other examples can be found in the 2020 Bridges Poetry Anthology [9].)



Figure 2: PH4 mathematical poetry workshops at Du Beast (Berlin, 2019) and Bridges 2018 (Stockholm).
Photos: S. Gerofsky

Walking in rainy woods, evening

Whose woods these are I do not know
These are whose woods? No, I do not
These are – no -- whose woods I do not
Know these are I do not whose woods
Know I do not these are whose woods
I do not know whose woods these are.
I do not whose woods know these are.
Whose woods I do not -- these are – no,
Whose woods these are I do not know.

Rough leaves tickle skin
Leaves rough skin tickle
Leaves skin rough tickle
Skin leaves tickle rough
Skin tickle leaves rough
Tickle skin rough leaves
Tickle rough skin leaves
Rough tickle leaves skin
Rough leaves tickle skin.

Walking holds us in companionable silence -
Holds us in walking silence, companionable;
Holds us in silence, walking companionable.
Silence holds us in companionable walking,
Silence, companionable, holds us in walking
Companionable silence walking holds us in
Companionable walking silence holds us in.
Walking companionable holds us in silence;
Walking holds us in companionable silence.

Spines' close touch trembles
Close spines trembles touch
Close trembles spines touch
Trembles close touch spines
Trembles touch close spines
Touch trembles, spines close
Touch spines trembles close
Spines touch close trembles
Spines close, touch trembles.

Without this suffering we bear
This without, we bear suffering
This we bear without suffering
We bear this suffering without,
We bear suffering this without
Suffering we bear without this.
Suffering without, we bear this,
Without suffering, this we bear
Without this suffering we bear –
With promises to keep.

And miles to go before we sleep
To go and miles we sleep before
To go, we sleep, and miles before
We sleep to go before and miles
We sleep before to go and miles
Before we sleep, and miles to go
Before and miles we sleep to go
And miles before to go we sleep
And miles to go before we sleep.

(Readers will notice that I have taken some liberties in 'escaping from the labyrinth I have built', exercising artistic license for poetic effect in this multi stanza piece. I've given myself the liberty of choosing either one-word and/or multi-word phrases as the units for permutation, and have added a tenth line in stanza five, intentionally echoing Frost's original poem.)

As mentioned earlier, I have used this form in workshops with groups of mathematicians, poets and students. Four participants each choose a word or short phrase, write it on a card, and then speak just their word aloud in PH4 permutational order as a performance for the larger group (Figure 2). It has been interesting to note participants' preference for enacting the poem through a dance movement, physically swapping places with one another, rather than standing motionless and swapping word cards.

Research work in embodied mathematics learning at small, medium and large scales supports the effectiveness of this whole-body, large scale physical engagement, where participants are like parts of a

moving machine, as a way of grasping a pattern ‘from the inside’, whereas small-scale engagement (for example, an individual writing out the poem on a piece of paper) allows a person to have individual control of the whole process, as if they held ‘the universe in their hand’ [6, 12]. I postulate that it is the purposeful alternation of small, medium and large scale embodied engagements that best supports mathematical understanding, as we bring insights from ‘being the pattern’ and ‘controlling the pattern’ into our experiential and conceptual ways of knowing.

(2) Anagrammatic, Anglo Saxon-inspired poems

While PH4 poems rely on permutations on the level of words and phrases, anagrams are permutations on the level of spelling and letters, with the additional constraint that acceptable permutations must constitute valid English language words, based on a particular dictionary. This constraint is a powerful one, creating limitations that help select meaningful words from the very large numbers of possible permutations. For example, the five letters *a, e, m, s, t* have $5! = 120$ permutations, but only 5 of those create valid English words (*meats, mates, teams, tames, steam*). Anagrammatic permutations on a set of letters can produce a set of words interesting to poets because (1) they share sounds (based on the reasonably stable letter sounds in English), allowing for assonance and consonance, and occasionally alliteration and (2) particular clusters of letters/sounds known as phonesthemes carry the suggestion of semantic fields or meanings – for example, a cluster of English words like *glimmer, glisten, glow, gleam, glister* and others have related meanings associated with light and shininess (see [4] for the origins of the concept of the phonestheme).

I play a 5- and 6-letter anagram game on my phone, and have been collecting the most poetically interesting sets of anagrams over several months to create a new kind of poetry. For the Bridges 2019 poetry reading, I brought these anagrams together with inspiration from the rules of Anglo Saxon poetry, a form used in Old English poetry from the 7th century CE to the period of the Norman Conquest in 1066, and adopted by modern poets including Gerald Manley Hopkins and Canadian poet George Johnston. Anglo Saxon poetry seemed particularly interesting in offering further constraints to anagrammatic poetry because of its emphasis on alliteration and consonance rather than rhyme, and its interesting practice of inserting a meaningful pause, *caesura* or line break in the middle of each line of poetry, allowing the second half of the line to provide a commentary or completion in relation to the first half of the line. Here are the rules that define this new *Anagrammatic, Anglo Saxon-inspired* poetic form, the first my own constraint, and the other four inspired by Anglo Saxon poetic traditions.

1. **Anagrams** of words in each line of the poem.
2. **Blank verse** (no end rhymes).
3. **Caesura** (or break) near the middle of each line, allowing for a breath or pause and the use of topic-comment syntactic structure.
4. **Consonance and assonance (the repetition of consonant and vowel sounds)** within and between lines and across the caesura. (Note that Anglo Saxon poetry incorporated the stronger constraint of alliteration -- the repetition of the initial sounds -- of two words in the first half of each line, and at least one word after the caesura.)
5. **Kennings**: metaphorical phrases used to compare a figurative description to something less elegant.

In preparation for writing my first poem in this new form, I copied out the list of the anagrams I had collected, and was very surprised to see that it extended to seven handwritten pages with 163 distinctive anagram sets! (Six months later, the list is now even longer.) Figure 3 is an excerpt from the anagram list, and the following is the poem I wrote from it, “Legato Gelato”.

- (2) 23
- curate acuter
 - flog golf / Geldof golfed
 - ochres chores
 - ogre ergo
 - thicken kitchen
 - browse ~~brows~~ bowers
 - censor cranes
 - bruise rubies buries busier
 - stakes skates steaks
 - Earth heart
 - glided gilded
 - denial nailed aligned Daniel
 - easier aeries
 - canten cannot
 - slaves salves
 - flars fibers rifts lifers
 - enrds laners
 - silver livers sliver
 - stripe spnte tripes rijest
 - steals steats priest ...
 - cubist cubits
 - curse cures sucre cruse
 - latent talent
 - shles islets sliest
- (4)
- Angel glean angle
 - tires tarsi trios riots
 - feast feats fates fetas
 - plane penal panel alpen Nepal
 - links films slink
 - exalt latex!
 - organ groan
 - treason senator
 - reside desire eiders
 - antsy tansy
 - peccis escape
 - saker snare hears carns
 - renal learn
 - mares miser smear reams
 - cedar cadre cared arced raced
 - utters truest
 - sift fist
 - remain marine airmen
 - greets egrets
 - astute statue
 - eiter revite relive levier
 - theses sheets
 - impart armpit

Figure 3: Two of seven handwritten pages of anagrams the author used to compose “Legato Gelato”.

Concluding remarks

New combinatoric mathematical poetic forms like the two introduced in this paper have the potential to create patterned language incorporating ‘enabling constraints’ and free play in a way that might appeal to mathematician/poets, in the traditions of the puzzle-verses of mathematicians from Lewis Carroll to the Oulipo group. Poems written in these forms have distinctive and interesting qualities that make them ‘good poetry’ as well as interesting puzzles. From a mathematics educator’s point of view, they also allow for embodied, movement-oriented and vocal ways of experiencing and understanding combinatorics, deepening the appeal and understanding of related mathematical concepts.

Legato Gelato

Adepts pasted sateen
The palest pastel petals —
To please those senators asleep to treason

They tended dented sacred cedars
Dropping a peremptory crusty curtsy
Sirens applied rinses
Ochres thicken
Bruise earth's rubies
Silver livers sliver
She poises her burden
Serves and severs verses,
As the lifter of fares

The signer may resign
If we reared a dearer reader
To browse bowers shaded

"Drink up the latest lattes
And let Andrew wander,"

Padres rasped and parsed prayers
Gobbling sauces for good causes,
Slump lumps of plums,
Burning tapers at the dregs of the repast
To a lewder welder, and a stray artsy satyr,

What care we if the acuter curate flogs golf
Those are ogres who censor crones
The clergy enrols loners
A priest places the ripest tripes
Their denial nailed Daniel
Those saints whose hoarse cry
In their craven cavern
Who enters, the nester
The chaser who would search arches
Their mimosa Maoism
Strew straw on warts
Their manse means our names

Desire resides in eiders,
Deist diets stanch edits to tides
Re-echo and cohere
Sonic icons to scold cold's clods
And miles of slime,
We remain marine airmen,
The penal plane where angels glean angles
Is a saner snare for he who nears
They saw ladies' ideals of shoe and hose
The shale hales, leash heals,

to podiums of the senate,
stapled plates to pleats
whose elapsed duties suited them too well

that scared cadres had chopped with chesty scythe
to entrap a curt parent
to resins
kitchen chores
and buries busier hearts
the risen siren
of burned posies
stayed steady
fears and filters safer trifles.

and the singer reign
and reread their latent talent
with bowser's drowsy dreams.

and a macho mocha
warned the warden;

spread drapes, and spared no splendor
blows upon basting bowls
sipped rustic citrus
as a barbed dabber prates on taming mating
licking the tray of grease, agrees.

and the parson wears aprons?
ergo, their censers give no salves to slaves
curses cures with a cruse of *vin sucré*
in the easier aeries, attracting a stripe of sprite
alined to organ's groans.
stains satins ashore
drawn by the allure of laurel;
quick to resent tenses times?
repels lepers, erase saree
that scares a simple caress.
and nurse the secret runes —
will mingle mares' manes with amens.

greet egrets with sharp harps
sited on beaches where a snatch of chants
to the horses on lonely shores
scions of coins
sour limes to bring a smile.
allied with he who utters truest
in alpen Nepal
and earns peace's escape;
as they sailed seaward
legato gelato, amen.

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