Gathering 4 Gardner 13
Presentation Directory

Speaker	Presentation	(Tentative) Schedule
Bill Ames *Boston College, USA*	Extending the 10958 problem In 2014, Inder Taneja* proposed a math problem: Take all of the digits 1 through 9. Between the digits, place any mathematical operators (+ - * / ^) you wish. Use parentheses freely. You may also omit operators between (say) 3 and 4, and treat that operand as the number 34. See how many different integer results you can produce. Taneja's goal was to find all integers in the range [0 .. 11,111]. He succeeded for all integers except 10958, hence the name of this talk. I love this problem because it is easy to state, anyone can try it, and the insights gained while working on the problem are rich and fascinating. Several others have found that by allowing square roots or factorials, you can find 10958. By using other techniques described in this talk, I blasted through Taneja's range and the range [0 .. 111,111] and am well on my way to the range [0 ... 1,111,111]. This was achieved mainly by using non-integer yet exact number representations that still achieve exact integer results. I propose to explain these number representations, the progress so far, and seek suggestions from the audience for going yet further. *https://arxiv.org/abs/1302.1479	*Early Sun PM*
Gary Antonick *Stanford University, United States of America*	Thirteen Bounces Fire a cannonball at a perfect reflector. If the cannonball and reflector are positioned in a particular way, the cannonball will return exactly to the cannon. How might the cannon and reflector be positioned so that the cannonball returns after exactly thirteen bounces--and how might this positioning be estimated by using a compass and ruler?	*Early Thu PM*
Adam Atkinson *ELHP*	Medieval French Poetry I will describe three collections of unusual medieval French poetry, one of unusual medieval German poetry, and one of unusual fairy tales in English. These may be of interest to those who like the works of the Oulipo, described by Martin Gardner.	*Late Sat PM*
Duane A Bailey *Williams College, United States of America*	A Grammatical Approach to the Curling Number Conjecture We present new results on curling sequences composed of 2's and 3's. We demonstrate an interesting relationship between the tails of curling sequences and words in the language of an aperiodic grammar.	*Early Sat PM*
Thomas Francis Banchoff *Brown University*	Foxtrot Half-Empty Half-Full Problem, including 13 In 2005 the precocious sixth grader in Foxtrot queried his family members whether his (2-dimensional) cup filled halfway up was half-empty or half-full. Receiving four answers he revealed that it was 5/12 full and 7/12 empty. A good elementary problem is to determine the ratio of top to bottom for his cup, and to generalize to higher dimensions for cups with circular top and bottom or square top and bottom or mixed top and bottom. One type has top and bottom totaling 13 for G4G13.	*Early Sat PM*
Spandan Bandyopadhyay *Avanade*	Hexprimes Playing fast and loose with the definition of prime numbers to invent a new class of primes, called hexprimes, and an exploration of their properties.	*Early Sat AM*
Donald Bell *personal contribution*	Loyd Polyominoes A hundred years ago, Sam Loyd showed how to dissect a Greek Cross (one of the twelve pentominos) into a square (one of the five tetrominos). It is quite difficult to find a small set of puzzle pieces that can make all 17 of these polyominos. This talk will outline the methods used to reduce the number of pieces to just eight. The set of eight pieces will be in the Exchange Bag and there will be a paper giving more details in the Exchange Book.	*Early Fri AM*
George I. Bell *Tech-X Corp., United States of America*	The Sailing Stones of Death Valley In a dry lake bed in Nevada sit ordinary rocks up to 100 kg in weight. These rocks are unusual because of the tracks they have left behind in the dried mud, some tracks are over 200 m long. Scientists have struggled for years to find a natural process capable of moving these rocks over such distances, leaving pseudo-scientists free to speculate, and hoaxsters free to confuse the issue. We will discuss the current status of this mystery and lessons learned which could help in resolving other scientific controversies.	*Early Sat PM*
Alex Bellos *Alex Bellos*	Puzzle Ninja Alex went to Tokyo to investigate its puzzle culture. In this talk he reports on why and how the country has become the world superpower in logic puzzles.	*Early Sat AM*
Elwyn Berlekamp *UC Berkeley*	Sol Golomb tribute video 5-minute video prepared by Elwyn.	*Early Fri AM*

Elwyn Berlekamp
UC Berkeley

Gallimaufry of Games

Late Sat AM

Elwyn will provide a 12-minute video.

Tom Bessoir
none

prime perfect

Late Sat PM

I would like to show my short mathematic based experimental film. prime perfect "See and hear prime numbers! And a few perfect numbers too!" Tom Bessoir 2016 6 minutes 24 fps color sound My film was inspired by artist Tony Conrad's 1965 film "The Ficker." The vast majority of the frames in this film are black. You will be sitting in the dark experiencing number patterns. The prime number frames (2, 3, 5, 7, 11, 13, ... 8,123) are white and the perfect number frames (6, 28, 496, and 8128) are red. The stroboscopic nature of "prime perfect" provides an intense viewing experience.

Colin Beveridge
Flying Colours Maths, United Kingdom

An Old-Timey Cipher

Sun AM

What could have been so sensitive that Robert Bunch - British Consul (read: spy) in Charleston, SC - would need to encode his despatches to his boss in DC? In this talk, Colin shares his analysis of three puzzling letters from a century and a half ago.

Manjul Bhargava
Princeton University

Some Magical Numbers and Their Uses in Magic and Mathematics

Late Sat AM

The study of recreational mathematics can often lead to the discovery of mathematical structures and numbers that are truly "magical". We discuss some beautiful such structures that have inspired remarkable magic tricks over the years, and at the same time have brought to light simple unsolved problems that have now become central research topics in modern mathematics.

Nancy Blachman
Julia Robinson Mathematics Festival

How I Finagled nearly 13 Invitations to White House Events in 2016

Late Sat PM

Megan Smith, an assistant to President Obama, asked me if I was interested in improving math education for the US in 2015. I immediately let her know that I was. I didn't hear back from her until about a year had passed. When she asked me again in 2016, not only did I say "YES," but in my presentation I'll fill you in on how I finagled nearly a dozen invitation to White House sponsored events before Trump took office.

Robert Bosch
Oberlin College, United States of America

Figurative Subgraphs

Early Sat AM

Given an image, a set of points in the plane, and a set of edges (pairs of points), we wish to find a Hamiltonian cycle (a "tour" of the points) or a spanning tree (a connected acyclic subgraph) or a spanning Eulerian subgraph (a connected subgraph for which all vertices have even degree) that most closely resembles the image. We present numerous examples, and we describe the opportunities and challenges involved in using 3D printing to highlight the structures of the resulting math/art objects.

Kenneth Brecher
Boston University

Introducing the PiTOP

Early Thu AM

Pi is certainly one of the most important numbers in mathematics, physics, engineering and, indeed, in all scientific and even some artistic subjects. I have developed a new object which makes Pi tangible in novel tactile, acoustic and visual ways. The PiTOP is a right circular cylinder made out of brass with ratio of radius r to thickness t equal to pi. Because of this design, when spun the object also precesses (or rolls) for a rather long time, leading to an ever increasing precession frequency as it falls, producing what is sometimes called a "finite time singularity". The resulting sound and interplay of ambient light with the PiTOP is intriguing to the ear and delightful to the eye which also results in a strong "motion after effect" illusion. In this presentation I will talk about the development of the object, and demonstrate its physical and mathematical properties.

Vladimir Bulatov
Shapeways, United States of America

Cross sections of three dimensional hyperbolic tilings

Late Sat AM

3d tiling of hyperbolic space is hard to visualize. One way is to place yourself inside of the tiling. More accessible way is to look at the cross sections of the tiling with various two dimensional surfaces. We present several examples of cross sections with hyperbolic planes, spheres, horospheres and equidistant surfaces (cyclides). The pattern created at such intersections have various interesting properties. The talk will present few animations of such cross sections when surface is moving via hyperbolic space. Examples are here http://bit.ly/2FFxxwi

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Howard I Cannon
howwords.com

Demonstrating math with carefully drawn triangles in JavaScript

Early Sat PM

A "careful" triangle drawing primitive ensures that two triangles drawn with a common edge will fit together perfectly, hitting every pixel once and exactly once. Drawing with such a primitive using the exclusive-or ("XOR") function allows for the demonstration of algorithms such as polygon-filling. To get some color, XOR can be logically extended as the addition of +1/-1 to a multi-bit pixel which is then mapped into a target RGB color. When coupled with a reversible circle drawing algorithm, animated graphics can be implemented that illustrate concepts such as Fourier series expansions and fractal patterns. Years ago, in conjunction with Bill Gosper, many of these ideas were developed on the Symbolics Lisp Machine using customized microcode to draw the triangles. Recently, a browser-based JavaScript implementation was attempted using pixel arrays and an HTML5 canvas. Surprisingly, on modern implementations like Google's V8, this code runs fast enough to produce very pleasing animations on a range of computers from modern desktops, to Raspberry Pi's, to cell phones. The talk will provide a demonstration. A web site, http://howwords.com/g4g, allows anyone to explore these graphics. The code is also being open-sourced.

Ben Chaffin
Intel

A Tale of Two Powers: Finding zeros in powers of 2

Sun AM

A search for the first power of two with 19 consecutive zeros, with no redeeming mathematical value, but some fun algorithms.

Derrick Chung
John Abbott College, Canada

An Elegant Solution to Rusduck's "A Study in Stud"

Late Sat AM

Fitch Cheney's Five Card Trick, popularized by Martin Gardner himself, is one of the most well-known mathematical card tricks. The basic premise is to use four playing cards to encode the identity of a hidden hole card to a partner. In 1957, in the third issue of his magic magazine "The Cardiste", J. Rusduck proposed as a challenge an extension to this trick. He wanted a version that would allow the hole card to be freely chosen by the spectator (instead of the magician). Though many have offered solutions to this problem (including Gardner, and Rusduck himself), they've all failed either the conditions given in the original statement or the spirit of the problem itself. What we offer here is a novel solution to Rusduck's challenge that is also easy to learn and perform.

Stewart Temple Coffin
self

Martin's Menace

Early Fri AM

I consider the problem of determining whether the one intended solution to a polyomino packing puzzle is unique. Many persons smarter than I have pondered this general kind of problem, but probably none more so than Bill Cutler. He has a computer program that attempts to count solutions with high degree of accuracy, but falls short of mathematical certainty. So my question is: Is it possible to count solutions with mathematical certainty? If not, is it possible to prove that it is not possible? Or on the other hand, might it be possible to prove that a mathematical solution must exist, even though not known? Fascinating questions.

Debora A Coombs
Coombs Criddle Associates

Geometry in five-dimensions: Building quasicrystals from Penrose tiling

Late Thu PM

Penrose tiling provides a two-dimensional analog to certain quasicrystals. By combining artistic exploration with mathematical insight into the five-dimensional nature of Penrose tiling we have begun to visualize the structure of quasicrystals. We are building mathematically precise sculptures of Penrose tiling raised up to a dimension of somewhere between 2 and 5. We have also devised algorithms to explore two-dimensional aperiodic tilings using color and perspective. These drawings sometimes reveal structural patterns that become sculptures. In January we built a mirrored glass and copper sculpture that attempts to reconstruct the crystallographic origins of Nobel prize winner Dany Schectman's famous five-fold diffraction patterns.

Robert P Crease
1: Stony Brook University; 2: Markforged

Super Thirteen: Welcome to G4G's Teenage Phase!

Early Fri AM

Congratulations G4G, you have reached the teenage years! Where better to celebrate your coming of age than Georgia, the 13th colony? This talk celebrates the unfairly maligned number of G4G's maturity.

Robert P Crease
Stony Brook University

How is Science Denial Possible?

Late Sat AM

Science denial is now an established feature of the US political landscape. A loaded and politicized term, it refers not to the outright rejection of scientific authority, but only in select areas where political, economic, and religious interests come into play. Were Martin Gardner alive today, it would be in his crosshairs. How is it even possible in the 21st century? What can be done about it?

Erik Demaine
Massachusetts Institute of Technology, United States of America

Sliding Coins

Late Thu PM

Fonts, puzzles, and competition!

Yossi Elran
Gathering for Gardner

G4G's Celebration of Mind -- exciting the public and expanding MG's legacy

Early Thu PM

Per request from the celebration of mind committee, I would like to speak for 5 minutes about the CoM to show what we are doing and encourage more participants to take part in this worldwide educational venture.

Yossi Elran
Davidson Institute of Science Education, Weizmann Institute of Science, Israel

13 ways to tie a knot in a strip of paper

Sun AM

Knot theory is one of the most intriguing branches of mathematics. In this talk we will present 13 different ways to tie a knot in a strip of paper. Some of the methods are straightforward but others exploit topology to tie the knot in some unusual and unorthodox ways. As we work through the methods, we will mention the little understood connection between Mobius strips and Flexagons and present a nomenclature for twisted strips of paper.

Daniel M Erdely
Option.hu Ltd., Hungary

Spitron Bog

(TBA)

	How to build pyramids from the simplest Spidron spacefiller, the 4-sided Spitron? There are 5 kinds of Spitrons, but there is one among them what is suitable for building pyramids itself. How to find it and what other possibilities do we have if we allow different types to be used?What is this construction good for?	
Dick Esterle *the nomadic sphere herders of outer innerdom*	ALMOST 13 - ICOSAHEDRON let me count the ways Insights from my models and puzzles into the Icosahedron and sphere packing through the years. The Tetraball Puzzle and ICOSA 4 coloring.	*Sun AM*
Robert Fathauer *Tessellations, United States of America*	Knotting and Numbering Kite Tiling Rosettes A kite tiling rosette is a tiling with a single kite-shaped prototile and a singular point about which the tiling has rotational symmetry. Such tilings can be constructed over a wide range of kite shapes for all n > 2, and for concave kites for n = 2. They are two colorable and possess mirror symmetry about lines passing through the singular point. A finite patch of adjacent rings of tiles can serve as a scaffolding for constructing knots and links, with strands lying along tile edges. In addition, these patches can be used as grids for a variety of puzzles and games, including magic numbering.	*Late Sat PM*
Gwen Fisher *Bead Infinitum*	Beaded Tessellations of Polyhedra and Penrose Tilings Mathematics provides us with numerous examples of tesselations of polyhedra in various dimensions. These objects can be built with beads by aligning one a bead hole with every edge and weaving the beads together with a needle and thread. I will present photos of artistic examples that I have created with glass seed beads.	*Late Thu PM*
Greg N. Frederickson *Purdue University, United States of America*	Hidden in Plane Sight: the Extraordinary Vision of Ernest Irving Freese A geometric dissection is a cutting of a geometric figure into pieces that you can rearrange to form another figure. Dissections have had a surprisingly rich history, reaching back to Islamic mathematicians a millennium ago and Greek mathematicians more than two millennia ago. After the death of Los Angeles architect Ernest Irving Freese in 1957, his precious 200-page manuscript, chock-full of gorgeous geometric dissections, ``disappeared'' and wasn't recovered for more than four decades. Hidden within many of its dissections are remarkable uses of plane tessellations, nifty instantiations of mathematical identities, amazing forays into the structure of regular polygons, and spectacular hingings of the dissection pieces. Based on the speaker's recent book, entitled "Ernest Irving Freese's `Geometric Transformations': the Man, the Manuscript, the Magnificent Dissections", this talk will illuminate a number of Freese's lovely insights, and outgrowths.	*Sun AM*
James Emmett Gardner *Martin Gardner Literary Interests*	Growing up Around Martin Gardner: Another Round Martin's son Jim will reprise, as well as provide new, information and anecdotes about growing up around Martin Gardner. Time for questions from the "Gathering" will be included.	*Early Thu PM*
Lucas Garron *Lucas Garron*	The Perfect Easing Function If you animate an object going from one position to another, you can smooth out the motion by using a non-linear "easing function" to tweak the progress from 0 (start) to 1 (end). I'll explain why the easing function 10x^3 - 15x^4 + 6x^5 has some nice properties.	*Sun AM*
William Gasarch *University of Maryland, College Park, United States of America*	The Muffin Problem At G4G12 I (William Gasarch) saw a pamphlet Julia Robinson Mathematics Festival: A Sample of Mathemaical Puzzles Compiled by Nancy Blachman. On Page 2 was THE MUFFIN PUZZLE which asked about the problems: If ther eare 3 muffins and 5 students and you want to give everyone 3/5 of a muffin, how do you do this and maximize the smallest piece? The pamphlet also asked about 3 muffins and 5 students, 5 muffins and 3 students, 6 muffins and 10 students, 4 muffins and 7 students. Nancy Blachman atributes the problem to Alan Frank, as described by Jeremy Copeland. We have looked at the problem for general m,s. Let f(m,s) be the size of the smallest piece in the optimal procedure. We have many general theorms about f(m,s) (for example f(m,s) = (m/s)f(s,m)) and have used them to determined the answer for all 1 LE m LE s LE 50. Our work is accessibly to high school students (indeed- several of the co-authors ARE high school students!) but uses some math of interest-- Linear algebra and mixed integer programming.	*Late Thu PM*
Darren Glass *Gettysburg College, United States of America*	Chutes and Ladders Without Chutes or Ladders Evert parent has wondered what size spinner you should use if you want to get a game of Chutes and Ladders over with as quickly as possible? Solving this problem involves tricky Markov Chain calculations, but becomes much more elegant if one removes all of the chutes and ladders from the board. We will discuss this situation, as well as what happens when one tries to strategically place a small number of ladders back on the board.	*Early Sat PM*
Jordan Gold and Elan Lee	How we built the world's smartest computer with a few pieces of cardboard and a pineapple	*Late Thu AM*

Professional Magician, United States of America	TBA	
Susan Goldstine *St. Mary's College Of Maryland, United States of America*	Symmetry Samplers In the past decade, a number of mathematical artists have explored symmetries in different fiber arts (embroidery, bobbin lace, knitting, and so forth), developing a hybrid of traditional crafting and mathematics: the symmetry sampler. We will take a colorful tour through illustrations of this novel art form.	*Sun AM*
R. William Gosper *1: Los Altos Center for Outrageous Claims; 2: UCLA*	True planefills versus "Spacefilling Curves" Don't believe anybody who tells you that some recursive zigzag doodle is a "spacefilling curve". Or that it has a "limit". The popular pictures of Dragons and Hilberts, &c are, at best, polygonal approximations to true planefills, which are a lot more wonderful.	*Early Thu PM*
Adam P. Goucher *DPMMS, University of Cambridge*	Evolving lifeforms on lattices In October 1970, Martin Gardner famously introduced the world to Conway's 'Game of Life', a simple set of rules exhibiting breathtaking emergent complexity. We explore a wide range of lattice-based rules which are more conducive to supporting rich interactions and biological processes such as reproduction, digestion, and evolution.	*Early Thu PM*
Theodore Gray *Element Collection, Wolfram Research*	Mechanical Gifs I will describe and show examples of a concept I have been working on in connection with a new book project. What I call "Mechanical Gifs" are real, physical objects made of laser-cut acrylic, which attempt to serve the same purpose as the animated gifs one often sees used to explain simple mechanisms. As such, they are simplified, stylized representations of the essence of a mechanism (lock, engine, transmission, etc), realized in physical form but made transparent so their function is obvious. (Or, as I like to say, they are transparently obvious.) In my talk I will describe my design principles and share some insights from the experience of designing not only the models, but also the system for manufacturing them in quantity. Details at http://mechanicalgifs.com	*Early Sat PM*
David Michael Greene *Crane Mountain Enterprises*	Self-Construction in Conway's Life Recent discoveries in the Game of Life have made it much easier to put together patterns that construct other patterns, including complete copies of themselves. This talk aims to give a high-level overview of developments in universal constructor technology, from1970 to 2018 -- incremental progress in the direction of John von Neumann's self-replicating machines from the 1940's.	*Early Thu PM*
James Grime *Maths Gear*	Nontransitive dice for three players Martin Gardner first described nontransitive dice 1970. The numbers on the dice are chosen in such a way that you can always pick a die with a better chance of winning than your opponent. But what about three player games? Is there a set of dice that allows you to best two opponents at the same time?	*Early Thu AM*
Rik van Grol *Nederlandse Kubus Club, Cubism For Fun*	Balance puzzles -- you either love them or curse them Balance puzzles challenge the puzzler to manipulate an object to bring it into balance, e.g. the Columbus Egg. The puzzle leaves the puzzler in the "dark", there are no or hardly any visual clues. In order to solve the puzzle other senses need to be used, e.g. hearing, tactile sense, combined with imagination and logic, and of course persistence. Not everyone likes that. This presentation will give some striking examples. An accompanying paper provides an overview.	*Late Sat PM*
David Hall *vZome*	Recipe for a 'bola Honeycombs A hexagonal grid and simple integer addition can be used in a manner reminiscent of Pascal's Triangle to generate a set of coordinates which all fall on a three dimensional surface called a paraboloid. The grid generates the vertices of affine hexagonal facets which bound an infinite polyhedron that I have dubbed the "Parabolahedron" (hence 'bola in the title). The entire parabolahedron is completely determined by the choice of four "seed numbers" from which the entire polyhedron is derived. An infinite variety of these parabolahedra may be generated by choosing different "seeds". Once completed, a grid can be used directly for modeling a paraboloid by stacking anything from coins to Honeycomb cereal in stacks corresponding to the values in the grid. The result is a paraboloid shaped "bowl". Since the process of generating the honeycomb grid requires only integer addition, it is a suitable puzzle for students in early elementary grades. Any of several pre-calculated grids could be provided to allow even younger students who are just learning to count to generate variants of the "bowl" shape by stacking simple objects such as coins. At the same time, the geometric progression of the grid can be used in more advanced studies of topics including averages, slope, volume, exponential growth, symmetries, conic sections, quadric surfaces, vector addition and affine transformations.	*Early Sun PM*
Raymond Hall *@physicsfun on Instagram and Facebook, United States of America*	Physics Fun: The use of Social Media as a Museum of Science and Math @physicsfun is an Instagram account where one can find videos of 60 seconds or less, posted daily, and featuring content of curious and often surprising	*Early Sat PM*

phenomenon of physics or math. According to Webster's Dictionary, a museum is "an institution devoted to the procurement, care, study, and display of objects of lasting interest or value", and my social media account strives to meet this definition with the spirit and philosophy of Frank Oppenheimer's Exploratorium. The content is primarily my personal collection of physics toys and scientific curiosities, and the patrons are 880,000 followers from around the globe, where a typical post receives more than 20,000 responses (likes). This presentation will describe the content, production, and impact of this science outreach effort.

George Hart
Stony Brook, NY

Mathematical Construction Activities During the Excursion

Late Fri AM

On the excursion to Decatur, there will be a number of hands-on mathematical construction activities for participants to enjoy. This presentation will very briefly summarize the activities, so you know what to look for.

George Hart
Stony Brook, NY

Tying the Knot

Early Sun PM

How can an ordinary rubber O-ring, which is just an unknotted circle, be converted into a knotted loop? And how can one efficiently produce hundreds of them, to give as gift-exchange items?

Barry Hayes
self

Wieringa Roofs: The Lost Penrose Variant

(TBA)

In N.G. de Bruijn's 1981 "Algebraic theory of Penrose's non-periodic tilings of the plane", there is a brief reference to R.M.A. Wieringa, and his observation that a labeling of the vertices of the Penrose rhombus tiling leads to a 3-D construction using only a single kind of rhombus. The projection of this 3-D tiling is the Penrose rhombus tiling. de Bruijn comments, "These three-dimensional patterns seem to be promising for construction of ceilings in big rooms (rather than for floor tilings!). Let us call them Wieringa roofs." The Wieringa roof remains largely unknown. Its time has come. https://ac.els-cdn.com/1385725881900160/1-s2.0-1385725881900160-main.pdf

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Bob Hearn
self

There are only 15

Late Thu AM

The problem of how many convex pentagons tile the plane, first considered in 1918 by Reinhardt, later popularized by Martin Gardner, and contributed to by Marjorie Rice, was finally resolved by Michael Rao in 2017. I will briefly describe the proof, as well as my own unsuccessful attempts to resolve the problem.

Paul Hidebrandt and Amina Buhler-Allen
Zome, United States of America

A tribute to Marc Pelletier

Early Sat PM

Personal reflections on playing and working with the visionary artist and mathematician, Marc Pelletier, through the eyes of two of his closest friends.

Akio Hizume
Geometric Artist

Fibonacci Jigsaw Puzzle etc.

Early Thu AM

I made a jigsaw puzzle based on the Phyllotaxis. It is a new magic and illusion. It is also used for mathematical education toy. This puzzle is based on the golden ratio, the Voronoi tessellation and the Fermat Spiral. And I will show many 3D printer geometric models.

Carl N. Hoff
Applied Materials

From Untouchable 11 to Hazmat Cargo

Early Sun PM

Untouchable 11 is a packing puzzle designed by Peter Grabarchuk. This paper describes Untouchable 11 and its 'untouchable' concept, and explores applying this concept to other hexomino packing puzzles. Every untouchable packing puzzle can be mapped to an equivalent conventional packing puzzle (in which pieces can touch), enabling the use of existing software tools for analysing untouchable packing puzzles. Exploring this puzzle space led to the creation of a new puzzle, Hazmat Cargo.

Brian Hopkins
Saint Peter's University

Difference Dice

Early Thu AM

Among the many amateur mathematicians championed by Martin Gardner, George Sicherman is now known for two 6-sided dice that are not labeled 1, 2, 3, 4, 5, 6 yet have the same frequencies of sums as a standard pair. Finding such dice for various sizes is a nice application of factoring polynomials. What about finding dice whose differences match a standard pair? There are such, more than you might guess. This talk is a plea for a mathematical structure to handle finding these difference dice for various sizes.

Lyman Porter Hurd
Google, United States of America

Kadon's Dezign-8

Late Sat PM

Dezign-8 is a tiling puzzle by Kadon (www.gamepuzzles.com) in which every valid solution has some unusual invariants such as the fact that the shapes always have the same number of loops as connected components and the number of loops can take any value for 1-19. In this talk I give a quick proof of these facts and also describe how these properties can be used to optimize a search for symmetrical maximal solutions.

Masayoshi Iwai
Academy of Recreational Mathematics, Japan(ARM, Japan), Japan

Tilings of Equilateral Tridecagons

Early Sun PM

I thought about 13-gon shapes for 13 of G4G13. I collected tiling patterns of equilateral tridecagons. I'll show them to you by pictures and movies.

Hirokazu Iwasawa
Individual

Classic False Coin Puzzles without Mathematical Induction

Early Thu AM

This talk deals with some classic puzzles to find a false coin with a balance or a scale. An example puzzle is to find a false coin among 14 coins with one false, either heavy or light, by using a balance three times when you have a true coin other than the 14 coins. Another is to find a false coin and determine the weights of every coin among 31 coins with one false, either heavy or light, by using a scale five times. In an ordinary way to solve those problems, you first consider cases with small number of coins and find a general solution by a mathematical induction. But this talk presents a "deduction" way to find general solutions for them. (Please don't say we always and already use mathematical inductions implicitly whenever we use integers.) The way introduced in this talk is, I think, a fun if not novel, and I believe it's educational, too.

Kate Jones
Kadon Enterprises, Inc.

Lucky 13

Early Sat AM

I will show a PowerPoint slide show of 13 beautiful puzzles of 13 different tiles each with 13 amazing solutions, all designed by Michael Dowle, and an introduction to the "Cookie Jar" puzzle Kadon Enterprises, Inc., is publishing of one of the 13 styles, having its world premiere at G4G13. Fascinating mathematics in artistic form.

Gabriel Doran Kanarek
self

Repetitive Patterns in the Juggler Sequence

Late Thu PM

A Juggler Sequence is an integer sequence similar to the Collatz, where you start with an integer 2 or greater. If it's an even number, you take the square root, and if it's an odd number you take the square root and cube the result (in both cases you use the Floor function to get it back to an integer), and repeat until it gets down to 1. We know that the sequence always gets to 1 for numbers up to 1,000,000, but it hasn't been proven yet for all numbers. I am looking at repetitive patterns in subsequences to see if that will help.

Louis Hirsch Kauffman
University of Illinois at Chicago, United States of America

Rope Tricks and Topology

Early Thu PM

Many remarkable rope tricks are of equal interest as magic and as demonstrations of interesting topological and physical phenomena. This talk will demonstrate intriguing examples of this genre including the classic Chefalo Knot Trick, the Vanishing Chain Stitch and the Dirac String Trick.

Margaret Kepner
Independent Artist (no organization)

4 x 13

Early Sat PM

There are 52 cards in a standard deck of playing cards: four suits of 13 cards each. To design a deck of cards, one needs to establish the four suits, each with its own symbol and/or concept, and find a logic for generating the 13 cards in each suit, usually related to the numbers from 1 to 13. My talk will present my progress to date in designing a set of playing cards based on ideas that Martin Gardner wrote about in his books and columns. In my current plan, the four suits are Circles (shape-packing), Tiles (polyforms), Triangles (geometric dissections), and Knots. For example, the "Eight of Circles" has an image of eight circles packed into a larger enveloping circle, while the "Seven of Knots" card displays the seven knots with seven-crossings. The design on the backs of the cards is a pinwheel tiling variant based on a recursive substitution of 13 right triangles into a larger triangle.

Tanya Khovanova
MIT, United States of America

Crypto and Fractal Word Searches

Late Sat PM

Modern twists on old word searches.

Scott Kim
GameThinking.io

Motley Dissections

Early Sat AM

This talk discusses motley dissections -- polygons cut into polygons and polyhedra cut into polyhedra such that no two pieces every completely share an edge or a face. The most famous motley dissection is the squared square. My contribution extends this to triangled triangles, pentagoned pentagons, boxed boxes, tetrahedraed tetrahedra, and octahedraed octahedra. I show many motley dissections in 2 and 3 dimensions, show how motley dissections are related to polyhedra in a manner similar to polyhedral duality, and in particular, show how the boxed box (a motley dissection of a rectangular solid into rectangular solids) is isomorphic to the 24-cell, one of the regular polyhedra in 4-space. (This talk covers the same material as in the paper and model I'm submitting for the gift exchange.)

Gergo Kiss
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The Derivation of the Spidron Formula

Sun AM

20 years ago Daniel Erdely asked me to visualize the deformation of his invention, the (hexagonal) Spidron. For this I needed to develop the suitable equations which I could enter into a visualization software. In this talk I would like to present the derivation I followed. (The Spidron is an initially plane-filling structure. It has the ability to move out of the plane to form a periodic, spiral-like 3D landscape, while keeping the shape of its building triangles intact.)

Peter Knoppers
TU Delft, Netherlands, The

The elusive 13 piece complete set puzzle

Sun AM

For G4G13 it is appropriate to involve the number 13 in the exchange gift. This presentation explains the design process of a complete set puzzle consisting of 13 pieces. The process has three phases: 1: Use a computer to find a complete set that has 13 members. 2: Design a geometrical implementation for the pieces of the selected set. 3: Design some shapes that can be filled with the pieces in not too many ways. Phase 1 found only one set; hence the title of this contribution.

Jane Kostick *KO STICKS LLC, United States of America*	13 Piece Puzzles I will present innovative wooden interlocking puzzles made of 13 pieces, designed and crafted by John and Jane Kostick.	*Early Thu AM*
Yoshiyuki Kotani *Tokyo University of Agric. & Tech, Japan*	Tiling of 123456-edged hexagon The theme is the tiling of flat plane by the hexagon which has the edges of 1,2,3,4,5,6 length, and that of other polygons of different edges. It is a very tough problem to make a tiling by a different edged polygon. Polygon tiling of plane often needs edges of the same lengths. It is well known that convex pentagon tiling has 15 type of pentagon. But only the first type does not have the pair of same edges. We found the tiling of 1,2,3,4,5,6-edged hexagon. It has two pairs of parallel edges. There are two types of the shape. We show the tilings visually.	*Early Sun PM*
Cindy Lawrence *National Museum of Mathematics, United States of America*	Play Truchet: Using the Truchet tiling to engage the public with mathematics In 1704, Sebastien Truchet considered all possible patterns formed by tilings of a square tile split along the diagonal into two triangles. This original tiling was modified to create a single tile consisting of two circular arcs centered at opposite corners of a square, resulting in an aesthetically pleasing, meandering set of mostly closed curves. MoMath has used this tiling in everything from bathroom decor to large-scale, public demonstrations, reaching thousands of people with this engaging mathematical tiling.	*Early Thu PM*
James Lee *self*	A Slick Solution to the Tax Man Problem On an annual basis, you get a gold disk of radius 1. You punch out a hole in the middle with radius r to give to charity. The tax man the cuts off as much as he can. He takes a straight line, without touching the charity circle. Can you figure out how to maximize your take home pay? Join James for a slick solution to this problem.	*Early Fri AM*
Anany Levitin *Villanova University, United States of America*	Polyomino Puzzles and Algorithm Design Techniques This talk is in memoriam of Solomon Golomb (1932-2016), a regular participant in the Gatherings for Gardner, who invented the name "polyominoes" for plane geometric figures formed by joining one or more equal squares edge to edge and wrote a seminal book about them. Martin Gardner popularized polyominoes in several Scientific American columns starting with the one in December 1957. My talk will give examples of polyomino puzzles that nicely demonstrate several major algorithm design techniques: recursion, brute force, divide-and-conquer, decrease-and-conquer, transform-and-conquer, and dynamic programming.	*Early Fri AM*
Dana Mackenzie *Freelance Writer*	2184 (Oh, the Absurdity) Define an integer to be absurd (literally, "without the surd") if it can be expressed as an integer minus a perfect root (or surd) of that integer. In symbols, n is absurd if it is of the form x^a - x. Likewise, n is doubly absurd if it can be written as an integer minus its surd in two different ways: for example, 2184 = 3^7 - 3 = 13^3 - 13. Finally, n is doubly strictly absurd if, in both of these expressions, the exponent is 3 or greater. Conjecture: 2184 is the only doubly strictly absurd number. I cannot prove this yet, but I will describe some small but nevertheless surprising progress toward a proof. This talk was inspired in part by Alex Bellos' talk on favorite numbers at G4G11 and by Matt Parker's video on "Why 2184 Was a Very Good Year to be Born."	*Early Sat PM*
Stephen Macknik *SUNY Downstate Medical Center, United States of America*	Champions of Illusion We would be interested in giving a presentation on The Best Illusion of the Year Contest, which is in its 13th year. We have chronicled the science behind the illusions in our new bestselling book: Champions of Illusion. We would be delighted to have a booksigning during G4G.	*Early Sat AM*
Roger Russell Manderscheid *self- Time Travelers League of Intrigue*	Misconceptions of Measurement: Time, Space and Numbers An explanation of how the human brain misunderstands and misconceives very large and very small numbers, distances and time.	*Sun AM*
Oded Margalit *IBM, Israel*	PonderThis IBM research runs a mathematical challenge site (www.research.ibm.com/ponder). Every month a new challenge is posted; as well as a solution for the previous month's riddle. Prof. Oded Margalit is the puzzlemaster, for the last decade. In the talk, he will survey some of the riddles over the years, and tell some anecdotes about the challenges and the solvers. For example: A PRL paper born from a riddle on random walks; ITA-2014 paper on water hose model (using quantum entanglement to break location based encryption); Games: 2048, Kakuro, Infinite chess game, the probability of a backgammon to end with a double, Fisher Foul Chess and more. Minimal hash function, Combinatorial Test Design; A solver from Intensive Care Unit and other stories; Finding a natural number n such that round ((1+2 cos(20))^n) is	*Sun AM*

	divisible by 10^9; We'll leave you with a still open question about Permutation-firing cannon...	
Henry Segerman and Sabetta Matsumoto *1: Oklahoma State University 2: Georgia Institute of Technology;*	Design of hinged 3D auxetic mechanisms Auxetic mechanisms are linkages that expand in all directions when pulled on. The classic example is the Hoberman sphere, a network of hinged arms formed into a sphere whose radius increases as the mechanism flexes. Our new examples are truly three-dimensional auxetics, tiling three-dimensional space rather than a two-dimensional surface.	*Early Thu AM*
Pete McCabe *I wouldn't want to belong to any organization that would have me as a member*	Persistimis Possessiamo My proposal for a Talk for G4G13 Pete McCabe Persistimis Possessiamo This presentation is an example of how to presenting a mathematical magic trick in a way that dramatizes the magic while concealing the math. In this talk I will perform a card trick on the entire audience at onceâ€"at least, everyone who has a deck of cards. The trick is called Persistimis Possessiamo and involves the audience casting a spell, choosing a card, losing it, and finding it against impossible odds. All without anyone else ever touching the cards. This trick appears in my book Scripting Magic 2, which was published this past December by Vanishing Inc magic.	*Early Sun PM*
Kate McKinnon *Contemporary Geometric Beadwork*	Engineering and Art: The Magic of the Kaleidocycle and the Contemporary Geometric Beadwork project As Doris Schattschneider is one of the featured speakers this year at the conference, I thought it might be fun to show some of the Contemporary Geometric Beadwork team's interpretations of the beautiful Bricard linkage presented in paper origami form in her 1970s book, "M.C. Escher Kaleidocycles". "Kaleidocycle" was the name that she and her co-author Wallace Walker coined for their (patented) folding form. We've created this and other many-faced Machines and linkages in tiny beads, using configurations of triangles, hypars, and tetrahedra. Each of them turn in several directions, like the paper fortunetellers some of us used to fold as kids. Our slide show will follow the geometric linkages of French mathematician Raoul Bricard as they appear in engineering, architecture, physics, paper (including the M.C. Escher book), and into our dreams of self-organizing, aware, morphing surfaces.	*Late Thu AM*
Alexa Meade *self*	2D+3D TBA	*Early Sat AM*
John Miller *Time Haven Media*	13 Parallels between Martin Gardner and Stan Freberg Gardner and Freberg had a curious number of co-incidences in their lives: Military service, magic, children's literature, and popularization of subject material. This talk/paper will compare timelines based on their autobiographies.	*(TBA)*
Rochelle Kronzek Miller, Jason Rosenhouse, and Elizabeth Carpenter *World Scientific Publishing Company, United States of America*	Honoring the Late, Great Storyteller of Logic - Raymond Smullyan Dr. Raymond Smullyan left us in February 2017. He will be greatly missed. Raymond left us with many gifts to remind us that problem solving, magic and logic can be entertaining, mysterious and fun. Over a 50-year span and during Raymond's nearly 98 years, he published over thirty books, many of them accessible trade puzzle books filled with stories, parables and key concepts of logic. Raymond wanted us to think and have fun at the same time. This session will celebrate the life and work of Raymond Smullyan. One of Raymond's last editors- DR. JASON ROSENHOUSE, will speak of Raymond's body of literature and his FOUR LIVES as an author, magician, pianist and philosopher. ELIZABETH CARPENTER will share video clips from a gentle conversation with Raymond at a rehabilitation center during the Spring of 2016 while Raymond was recuperating from pneumonia. ROCHELLE KRONZEK will share some remembrances of Raymond and Martin Gardner's relationship from the point of view of Raymond Smullyan himself. She will also share some of Raymond's deep felt Taoist philosophy taken from a manuscript draft that was to be entitled "Hippies through the Ages".	*Late Thu PM*
Ryan William Morrill *University of Calgary*	Playing nice with a weighted coin In probability theory, we say a game of chance is fair if each person playing it has an equal chance of winning. There are many ways you can conduct such a game, commonly using dice, cards or a coin. Using an unfair coin (ie the chance of heads is not 50%), how can you play a fair game of chance with several people? In this talk we will discuss an interesting combinatorial problem in which is easy to understand but not so easy to solve. Using an idea of "subtracting" rows of pascals triangle and looking at the divisibility of the resulting coefficients we will be able to generate some surprising solutions.	*Sun AM*
Stuart Moskowitz *Humboldt State University, Arcata, California*	Lewis Carroll Should Have Taught Sixth Grade Math In the late 1800s, Charles L Dodgson, aka Lewis Carroll, was a lecturer and tutor of Mathematics at Oxford University. Many historians, however, consider him uninspiring as a teacher. Of course, he will be remembered always as the author of Alice in Wonderland. But Dodgson also wrote on mathematics and logic, invented and collected mathematical puzzles and games, and was a prolific writer of letters and diaries. His register of all the letters he sent and received,	*Late Sat PM*

numbered to 98,721, and his diaries, now published, fill ten volumes. This presentation will show how his puzzles and games and letters enliven mathematics, making it meaningful, understandable, and even playful. After Dodgson visited an Oxford high school, Evelyn Hatch wrote: "...my old friend Mr. Dodgson offered to come and give us a lecture on logic. My fellow students prepared to meet the famous mathematical tutor...armed with notebooks and pencils. To their surprise the lecturer appeared with a large black handbag, from which he proceeded to draw a number of white envelopes to be distributed among the audience......we were to play a game!" Dodgson followed the guidelines within the new Common Core Mathematical Standards 100 years before they were written!

Colm Mulcahy
Spelman College, United States of America

Martin Gardner Word Play

Late Sat PM

Martin inspired both the Journal of Recreational Mathematics and the The Journal of Recreational Linguistics, both founded 50 years ago this year. Martin's favourite recreational mathematics puzzles are well known, so this is a good time to take a look at some of the anagrams, pangrams, lipograms, tautonyms, univocalics, and so on, that he sneaked into his voluminous writings.

Robert Munafo
Boston University, United States of America

Using the Analogue Approximation Finder

Early Sun PM

At G4G13 I will be giving away copies of my paper "approximation finder" (a sort of nomogram with many scales), which is similar to the exchange gift I offered at G4G12. In this talk I will give a brief demonstration of its use.

David Nacin
William Paterson, United States of America

Solutions to Klein Four Puzzles

Early Thu AM

We give an introduction to a class of puzzles definable over finite groups, focusing here on the Klein four group. We then describe a collection of tricks arising from the structure of this group, how they can be used to find solutions, and how they differ from methods needed for puzzles over the cyclic group of order four. We conclude with a classification of these puzzles which allows us to determine the number of solutions based on the position of the clues alone.

Mike Naylor
Matematikkbolgen, Norway

The Last Crumb

Late Sat AM

There's trouble when Mrs. McMurtle loses the lunch buffet and there's only one cookie left to feed an infinite number of people. Can George find a clever solution to feed everyone in a short amount of time? This illustrated poem in "Seuss-ian" style will have you scratching your head over ideas about infinity... and what happens with the very last crumb!

Akira Nishihara
A.R.M,Japan

Geometric toys

Early Sat AM

I show geometric toys, almost my original and handmade. (1) Delta-Star The type of Delta-Star corresponds to deltahedra. It expands and shrinks. Especially highly symmetric tetrahedron,octahedron,icosahedron types and deltahedorn 6,10 can transform smoothly. (2) Flexible hyperboloid Hyperboloid made by bamboo rods. (3) Torus toy At every point on a torus, four circles intersect. Two of these circles are trivial. The other two circles are the Villarceau circles, which are circles of the same radius. This torus toy consists of many Villarceau circles. It transforms flat, spherical, etc, furthermore it can turn inside out. (4) Black & white pattern toy Make two same black & white patterns. One is transparent sheet. Superimpose two sheets, move upper transparent sheet, then it appears a amazing pattern. (5) Jacob's ladder variations Traditional toy "Jacob's ladder" consists of two tapes & few blocks. One tape doesn't move while a block is "falling". So I have replaced one tape by rod, it worked well.

Hilarie Orman
Purple Streak

Mental Factoring

Sun AM

Find the factors of 5 and 6 digit numbers using only simple arithmetic and your own brain. No paper required. The secret methods of a number theorist revealed!

Miguel Palomo
Sudoku Ripeto and Custom Sudoku

The Sudoku Ripeto Family

Early Fri AM

In this talk I will present Sudoku Ripeto, a family of 30 Sudoku variants -one for each possible repetition pattern among 9 symbols- that includes classical Sudoku as a limit case. We will see puzzle examples of each variant, played with set of symbols 111222333, 112233445, 223334444 and others. We will also present the new techniques needed to solve Sudoku Ripeto puzzles.

Eleftherios Pavlides
Roger Williams University, United States of America

The Geometry of Motion of the Chiral Icosahedral Hinge Elastegrity

Late Thu PM

The Chiral Icosahedral Hinge Elastegrity resulted from a Bauhaus paper folding exercise, that asks material and structure to dictate form. The key new object obtained in 1982 involved cutting slits into folded pieces of paper and weaving them into 8 irregular isosceles tetrahedra, attached along 24 edges, to 12 right triangles, that in pairs form elastic hinges, creating an icosahedral shape held together by elastic forces. The chiral icosahedral hinge elastegrity has noteworthy physical and geometric properties. At G4G12, shape-shifting through further folding of the hinge elastegrity was presented. It led to a number of familiar geometric objects, as well as some new ones. It can flatten into a multiply covered square, morph into shapes with the vertices of each of the Platonic shapes, model the hypercube, as well as morph into new figures with the vertices of figures of congruent faces that are not regular polygonal regions.

With the help of co-presenter professor Thomas Banchoff, we generalized a unique new monododecahedron that had been obtained through folding, into a family of monododecahedra using analytic geometry. For G4G13 the proposal is to present the Geometry Of Motion of the Chiral Icosahedral Elastegrity. At rest the icosahedral hinge elastegrity has 6 openings framed by the 12 hinged triangles, that form gates that open and close, with a set of orthogonal axes going through their center and the structure's center. As the structure contracts into an octahedron, the gates close, and the tetrahedra pivot so that the 3 orthogonal axes extend thought the vertices of the octahedron. The gates open maximally when the structure expands back into a regular icosahedron. As the structure gyrates expanding into a cuboctahedron the slits close becoming 6 diagonals of the 6 squares of the cuboctahedron. The asymmetrical tetrahedra move along a second set of 4 axes that gyrate around the center of the structure. When two tetrahedra are pressed together, along any of the 4 axes, all 12 hinges are activated simultaneously, contracting the 8 asymmetrical tetrahedra chirally, spinning isometrically in unison along the 4 rotating axes, moving towards the center of the structure, into an octahedron. When any two asymmetrical tetrahedra are pulled away along one of the 4 axes, the hinges activate the entire structure extending the 8 tetrahedra spinning in unison with reverse chirality, along the 4 axes that rotate in reverse direction, pivoting around the structure's center, into a cubeoctahedron. When external forces are removed, elastic forces in the hinges return the structure into its original regular icosahedral shape. The presentation will involve a high quality model, that will clearly show how the elements of the chiral icosahedra move in coordinated fashion around the two sets axes, the orthogonal stationary and the set of rotating 4 axes. You can see a study model by copying and pasting this link into a browser. https://drive.google.com/file/d/1wW06ZK2zmItvCoDw36r4czw9zscxQ0cg/view?usp=sharing The five minute presentation will also use photos, diagrams. and short videos to explicate the geometry of motion. In addition to contributing a short paper I will bring 350 pre-laser scored and cut chiral icosahedral hinge elastegrity templates to pass out to the attendees to fold and weave their own model, to have a tactile experience of the elastegrity. I will be available for a workshop if participants need help to create the Chiral Icosahedral Hinge Elastegrity. PS An engineer collaborator is working on what happens to the distribution of forces as the hinge elastegrity moves. We may add later to the abstract, the equations of what happens to the forces as the icosahedral elastegrity expands into a cuboctahedron and contracts into an octahedron.

Joshua Pines

technicolor

Scrabble Seven-letter Words

Late Sat PM

This presentation analyzes various statistics for the English-language edition of the game of Scrabble. Specifically we investigate the mathematics of the seven-tile starting racks and seven-letter words, and determine the likelihood that a starting rack can make a seven-letter word.

Jim Propp

UMass Lowell, Mathematical Enchantments

You Can't Count to Thirteen ...

Early Sat AM

... if you're counting in base two-and-three! Sometimes a single string of digits does double duty, and represents the same number in two different (extended) bases; for instance, 212.1111112 represents the number thirteen in both extended unary and extended binary ("base one-and-two"). Every counting number has a unique representation in base one-and-two, and I'll show you a pleasant mechanical procedure for counting as high as you like in this base. But something very ugly happens with base two-and-three: you can count to twelve, but not to thirteen!

John Rausch, Nick Baxter, and Bill Cutler

self

A Fireside Chat with Stewart T. Coffin

Early Thu PM

TBA

Bernardo Recaman

1: Universidad de los Andes, Bogota, Colombia; 2: Colombia Aprendiendo, Bogota, Colombia

Ramanujan Sums

Early Thu AM

Given a multiset of postive integers, its P-graph is the graph whose vertices are the integers two of which are joined by an edge if, and only if, they have a common divisor greater than 1. Given any number, a handful of its numerous partitions are uniquely recoverable from its P-graph. We refer to these as Ramanujan Sums. The number of such partitions is sequence A298676 in the OEIS. Ramanujan Sums are challenging and diverse puzzles.

Andrew John Rhoda

The Lilly Library, Indiana University, United States of America

The Slocum Mechanical Puzzle Collection at the Lilly Library

Sun AM

This presentation will update the Gathering 4 Gardner community about activities related to The Jerry Slocum Mechanical Puzzle Collection at the Lilly Library, Indiana University's rare books and materials library. I will start with a quick introduction to the collection and how the puzzle collection is used at the Lilly. From there I will tell attendees how the puzzle collection has developed over the past two years. I will also describe recent outreach efforts regarding the Slocum Puzzle Collection, including the development of new ways to reach different communities at the university and in the local community.

Dana S Richards

gmu, United States of America

Martin Gardner, Annotator

Early Sat PM

Another in my series of biographical/bibliographical talks about Martin Gardner, the author.

Tomas Rokicki *Radical Eye Software*	HashLife William Gosper's HashLife algorithm has gained a mythical status in computing circles. After listening to this talk, you too will understand how this incredible algorithm works, and consider what other problems might achieve similarly astronomical speedups with similar ideas.	*Early Thu PM*
Erika Berenice Roldan Roa *CIMAT / OSU, United States of America*	Polyominoes with Maximally Many Holes In 1953 Solomon W. Golomb defined a polyomino as a rook-wise, connected subset of squares of the infinite checkerboard. The first polyomino puzzles were tiling problems. Most of the time in tiling problems one restricts to simply-connected polyominoes (i.e., polyominoes without holes). But almost all polyominoes have holes--the number of polyominoes with holes grows exponentially faster than polyominoes without holes. In this talk, we are interested in studying the asymptotic behavior of polyominoes with holes by exploring: What is the maximum number of holes that a polyomino with n tiles can enclose? In answering this question, we have found a sequence of polyominoes that reaches the maximum possible number of holes that approaches some limiting fractal shape. This sequence generates a non-periodic tessellation of the plane. We have also proved that the maximum number of holes that a polyomino can have, divided by the number of tiles, converges to 1/2.	*(TBA)*
Erno Rubik *self*	Cubic Tales In an "impromptu" discussion with G4G veterans, Erno will respond to so far unanswered questions and might challenge us with riddles that fascinate him.	*Late Fri AM*
Adam Rubin *Art of Play*	Functional Optical Illusions I would like to share some of my work in designing and constructing impossible objects that also serve a functional purpose. These include ashtrays, salt shakers and bowls that shrink, transform and multiply. I will also present a brief history of the classic optical illusions which inspired each piece.	*Early Thu AM*
Karl Schaffer *MoveSpeakSpin*	Edgy Puzzles Countless puzzles involve decomposing areas or volumes of two or three-dimensional figures into smaller figures. "Polyform" puzzles include such well-known examples as pentominoes, tangrams, and soma cubes. We will examine puzzles in which the edges of various symmetric figures like polyhedra are decomposed into multiple copes of smaller graphs, and see their relationship to representations by props or body parts in dance performance. For example, the edges of a tetrahedron may be composed of a folded octagon, while the cube and octahedron may each be composed of six folded paths of length 2. These constructions have been used in dances created by the author and his collaborators, often using lengths of PVC pipe. The shapes created by the dancers, which might include whimsical designs reminiscent of animals or other objects as well as mathematical forms, seem to appear and dissolve in fluid patterns, usually in time to a musical score. The desire in the author's dance company to incorporate polyhedra into dance works led to these constructions, and to similar designs with loops of rope, fingers and hands, and the bodies of dancers. Just as mathematical concepts often suggest artistic explorations for those involved in the interplay between these fields, performance problems may suggest mathematical questions, in this case involving finding efficient and symmetrical ways to construct the skeletons, or edge sets, of the Platonic solids. In one performance we present an audience member with the puzzle of folding a shape into a tetrahedron. In the 2009 show Harmonious Equations [2] we gave ourselves the puzzle of folding one shape wielded by three dancers into a cube and octahedron, and came up with a PVC pipe hexagon with pendant edges at each hexagon vertex, which also formed a doubled-edge tetrahedron. In [4] the authors showed classroom activities involving making polyhedra with PVC pipe, fingers, and loops of string; George Csicsery documented the latter two of these in a series of short films [1]. In various papers the author investigated modular constructions of the Platonic solids in a manner reminiscent of modular origami: in [5] the author showed how to construct the five Platonic solids with six loops of three colors, in [3] with length six PVC pipe modules and also with the bodies of six dancers, and in [6] constructions of the Archimedean solids and various plane tessellations. In this presentation we will explore various puzzles derived from the constructions similar to those described above using both simple props such as straws and pipe cleaners, which may be easily and chepaly constructed, or as puzzles in paper diagrams. References [1] Csicsery, George. Online films, at https://etherpad.mozilla.org/StringPolyhedraVideos, 2009. [2] Devlin, Keith (direction, text), Zambra (music), and Schaffer, Karl (choreography). Harmonious Equations, dance concert, Santa Cruz, 2009. [3] Schaffer, Karl . "One-dimensional Origami: Polyhedral Skeletons in Dance" in Origami 4: Fourth International Meeting of Origami, Science, Math & Education, ed. by Robert Lang, pp 75-83, A.K. Peters Ltd., 2009. [4] Schaffer, Karl; Stern, Erik; Kim, Scott. Math Dance. MoveSpeakSpin, 2001. [5] Schaffer, Karl. "A Platonic Sextet for Strings," College Math Teacher, January, 2012, reprinted in Martin Gardner in the Twenty-First Century, ed. by Michael Henle and Brian Hopkins, pp 19-24, Math. Assoc. Amer., 2012. [6] Schaffer, Karl. "A Skeleton Key for the Platonic Solids." In Kelly Delp, Craig S. Kaplan, Douglas McKenna, and Reza Sarhangi, editors, Proceedings of Bridges 2015: Mathematics, Music, Art, Architecture,	*Sun AM*

	Education, Culture, Phoenix, Arizona, 2015, Tessellations Publishing. Available online at http://archive.bridgesmathart.org/	
Doris Schattschneider *Moravian College*	The Story of Marjorie Rice A reader of Martin's column with no math training was inspired to do some original research which lead to investigations that are still ongoing.	*Late Thu AM*
Jaap Scherphuis *-*	Developments in Pentagonal tilings At G4G10 I presented a talk about my own research into tilings that use a single convex pentagonal tile. At that time only 14 types of tileable convex pentagons were known, but there have been some recent developments. - ---- Note: The ppt file of my slides is too large to be uploaded to the conftool, but can be downloaded from my site: https://www.jaapsch.net/g4g/index.htm	*Late Thu AM*
Ann Schwartz *Fantastic Flexagons, United States of America*	Making Waves: The Pentaflexagon Presenting a new flexagon: a regular pentagon made from a wavy strip of paper. The strips for a 4-faced and 8-faced pentaflexagon will be shown, along with demonstrations of how to fold and flex. The interesting characteristics of the flexagon will be discussed, including side exclusivity and its unusual flexes. Possibly a pentaflexagon with even more faces will be shown.	*Sun AM*
Nathaniel Segal *Magical Nathaniel, United States of America*	Deconstructing Magic Squares I would like to talk briefly about the history of magic squares, in particular 4x4, and explain my variation where you are able to put any (relatively small) number in any spot. I would like to discuss my approach coming from a theatrical background of being a magician and how this square can be constructed with little math or much deviation from a normal template square. This is also a square where you will be guaranteed no duplicate or negative numbers. I would also be open to giving a talk on magic, particularity from a creative angle, as I have designed and built many original illusions. I can even perform an effect and then deconstruct it to explain the process involved with the creation. I can talk about performing in front of 30,000 people of how I was able to combine classic effects in magic and juggling to create an original piece of magic.	*Early Sun PM*
Sabetta Matsumoto and Henry Segerman *1: Georgia Instutute of Technology; 2: Oklahoma State University*	Non-euclidean virtual reality The properties of euclidean space seem natural and obvious to us, to the point that it took mathematicians over two thousand years to see an alternative to Euclid's parallel postulate. The eventual discovery of hyperbolic geometry in the 19th century shook our assumptions, revealing just how strongly our native experience of the world blinded us from consistent alternatives, even in a field that many see as purely theoretical. Non-euclidean spaces are still seen as unintuitive and exotic, but with direct immersive experiences we can get a better intuitive feel for them. The latest wave of virtual reality hardware, in particular the HTC Vive, tracks both the orientation and the position of the headset within a room-sized volume, allowing for such an experience. We use this nacent technology to explore the three-dimensional geometries of the Thurston/Perelman geometrization theorem. This talk focuses on our simulations of H^3 and H^2xE.	*Early Sat AM*
Scott Sherman *n/a*	A Counterexample(?) to Fermat's Last Theorem A somewhat tongue-in-cheek counterexample to Fermat's Last Theorem that involves a number so large that it makes Graham's number look puny	*(TBA)*
Aaron Siegel *Airbnb*	Polyformer Polyformer is an extensible software toolkit for enumerating a wide variety of polyform types. The contribution is a paper describing polyformer and extensions to many OEIS polyform sequences. The software is open source and can be used to display arbitrary polyform sets and output STL files for 3d printing.	*Early Fri AM*
Erin Sledd *NA*	Title TBD Erin to enter description	*(TBA)*
James Joseph Solberg *Purdue University (retired), United States of America*	(Phi)ve is Magic The 'golden ratio' Phi and the integer five are linked in many surprising ways. In this talk, I will display a five-by-five geometric magic square that produces the same figure from the superimposed cells in in every row, every column, every diagonal, and many more patterns. That figure contains many instances of various powers of both Phi and five. A corresponding paper in the gift exchange provides details on this magic square and more connecting links through the Fibonacci numbers.	*Late Sat PM*
Charles Bernard Sonenshein *none*	How Martin Gardner Helped Me Keep My Sanity as a Math Teacher for 50 Years I would like to perform one of the math magic tricks from "Mathematics, Magic and Mystery." It was one that I used to get my students hooked on mathematics. The presentation will consist of comedy, fun, and participation of some audience members.	*Early Sun PM*

Barney Sperlin *none*	How Safe Is It? A mathematically based magic trick involving an invisible safe with an invisible combination lock, and invisible coins. The magician asks the spectator to do some arithmetic with the values that the spectator used to open the safe and the number of coins. When the single number is revealed at the end of the arithmetic calculation the magician knows the secret combination and the number of coins deposited.	*Early Sun PM*
Stacy Speyer *Cubes and Things*	From Weaver to Polyhedra Maker Stacy will show images of her artwork from large scale textile installations to polyhedra made with a variety of materials: triaxial woven reed, paper, and laser cut metal. This includes pages from her book 'Polyhedra: Eye Candy to Feed the Mind,' her series of 3D coloring books 'Cubes and Things,' and her latest pieces from her Artist Residency with the aerospace company, Planet.	*(TBA)*
Henry Strickland *Google*	Rainy Day Stories (in the Temporal Logic called D) There is a simple Temporal Logic by R. A. Bull called D. It's simple enough for kids to understand, but interesting enough to make puzzles. I haven't seen it used in Recreational Maths, and would like to introduce it.	*Sun AM*
Kokichi Sugihara *Meiji University, Japan*	Evolution of Impossible Objects Impossible objects were first proposed as imaginary 3D structures created in our minds when we see anomalous pictures such as a Penrose triangle. However, the impossible objects are not necessarily impossible; many of them can be constructed as real 3D structures, which I classified as the first generation impossible objects. Using the same mathematical trick, we can construct various types of impossibilities. Examples include the second generation "impossible motion objects" in which the objects look ordinary but inserted motions look to defy physical laws, the third generation "ambiguous cylinders" whose appearances change drastically in the mirror, and the fourth generation "partly invisible objects" which partly disappear in the mirror. I will show them and still other generations together with the mathematics behind.	*Early Sat AM*
Laura Taalman *James Madison University, United States of America*	Printing Perfect Pentagons There are 15 families of convex irregular pentagons that tile the plane, with the most recent discovered just a few years ago, and the proof that there are no additional families being settled only last year. Martin Gardner wrote about tessellating pentagons in the 1970's in his Scientific American column and inspired the discovery of five of the families, four of which were famously discovered by amateur mathematician Marjorie Rice and then brought to the mathematical community by Doris Schattschneider. In this short talk we'll share a method for constructing 3D-printable or lasercut models of any type of tessellating pentagon using OpenSCAD code, and go on a tour of tessellating pentagons being used in art, puzzles, housewares, and jewelry.	*Late Thu AM*
Michael Tanoff *Kalamazoo Area Mathematics and Science Center, United States of America*	Mr. Apollinax's Wedding Ring "That silver ring on your finger, Mr. Apollinax. Isn't it a Moebius strip?" That first piece of dialogue in Martin Gardner's Article, "Mr. Apollinax Visits New York" (Gardner, M., Martin Gardner's New Mathematical Diversions from Scientific American, Chapter 11, Simon and Schuster, New York, 1966) was the inspiration for a set of wedding rings permeated by mathematical richness and beauty, all inspired by Martin Gardner's writings.	*Sun AM*
Ron Taylor *Berry College*	Mathematics of color addition games The interaction between pieces in the color addition game Al-Jabar can be modeled as the abelian group Z_2 x Z_2 x Z_2. In this presentation we consider two alternative mathematical models of the color addition rules of this game and describe domino style pieces that can be used to play domino games using the same color addition rules.	*Sun AM*
Ricardo Teixeira *University of Houston - Victoria - Victoria, TX, United States of America*	Si Stebbins and Group Theory An algorithmic modeling of general Si Stebbins' sequence of a common 52-card deck is presented. We explore its relation to Group Theory and the broad mathematical properties that can be used in magic tricks. If time allows, we end with the applications of these concepts to magic card tricks.	*Sun AM*
ET Trigg *1939, United States of America*	Bidding in Contract Bridge considered as a communication channel Every bridge hand begins with an "auction" (i.e., the bidding) The bidding is one of three equally important parts of bridge (The other two are play of the hand and defense.) In addition to getting to name the "trump suit", the bidding is a cleverly designed and intensively studied system of communication. Many bids are "artificial" and convey messages to your partner about what you have in your hand. As a communication channel, bidding has a very narrow Channel capacity--a more relevant concept might be Throughput (the rate of successful message delivery over a communication channel). I plan to talk about a very general theoretical bidding system from the viewpoint of information theory, with the goal of telling your partner as much as possible about your hand. There are many interesting facts at the outset: 1. The channel is severely restricted: Not just any bid can be thrown in at any time, partly because the final bid in an	*Sun AM*

	auction must be in the desired trump suit. 2. The channel is public: If your bids tell your partner too much about your hand, it may also tell the opponents enough to defeat you. 3. The "auction" rapidly expands to use up all the bidding space: Once you reach the level of your "contract" you must stop bidding. 4. The channel is subject to interference: The opponents are bidding too and can often prevent you from making the optimal bid. 5. The channel is finite: There are about 10 to the 47th possible auctions but the vast majority of them are not plausible. (calculating the exact number is an interesting, but not too daunting, problem in itself.)	
Ryuhei Uehara *Japan Advanced Institute of Science and Technology, Japan*	Design Schemes for Fair Dice A cube is used as a fair die of 6 faces. However, there are many dice of different shapes on the market. To make them fair, most of them usually have some symmetric shapes. I classify these variants of dice on the market into two groups. First, let's consider that a sphere as a model of a fair die with infinity faces. Based on this model, many symmetric shapes can be modeled as dice obtained by caving spheres. We also have a familiar fair device; a coin. That is, a fair coin can be seen as a fair die with 2 faces. However, a real coin has a thickness, and hence it is, in fact, an unfair die with 3 faces. From this viewpoint, I propose a way for designing a fair die with n faces for arbitrary n. I also prepare fair dice with 13 faces as an exchange gift of G4G13.	*Early Thu AM*
Robert W Vallin *Lamar University, United States of America*	Maverick Solitaire and Three-Card Poker The version of solitaire where one deals out 25 cards to make five pat Draw Poker hands showed up in a January 1958 episode of the TV show Maverick. In this talk we examine how this type of solitaire lends itself to the casino game Three-Card Poker. We end with an open question on the "Ante Bonus" play of the game.	*Late Sat PM*
Tom van der Zanden *Utrecht University, Netherlands, The*	Packing polyominoes into a 3-by-n box is as hard as it gets A popular way of classifying the hardness of puzzles is by determining their membership of and completeness for the complexity class NP - essentially determining whether a certain kind of computation can be "represented" by an instance of the puzzle. The problem of determining whether a given set of polyominoes can be arranged into a given shape is NP-complete, and this is the case even if the target shape is a 2-by-n rectangle. From a classical viewpoint, this essentially settles the complexity. We take a more detailed look at this problem: we show that the problem of packing polyominoes into a 3-by-n rectangle is - in some sense (exact complexity) - even harder, but that moving up to 4-by-n or even root(n)-by-root(n) does not complicate things further.	*Early Fri AM*
Carlos Vinuesa	Dealing with Shuffles We will quickly study what happens with the repetition of general shuffles and riffle shuffles. Then we will take a look at very regular shuffles like the faro and its generalizations and we will understand their relation with cuts and the number of cards a packet needs to have in order for them to work well. Finally we will study the relation of these regular shuffles with dealing cards in piles.	*Late Sat AM*
Gerard Westendorp *Amateur mathematician*	Hinged polyhedra and hinged tessellations. Hinged tessellations are fairly well known. I first saw them in the "Penguin book of curious and interesting geometry", years ago. Since then, I generalized them to hinged polyhedra, and found a couple of interesting new facts about tessellations. I have a number of animations and working laser-cut models that I can show. (Including some new ones that are now unfinished but will be ready before G4G)	*Sun AM*
Glen Whitney *studioinfinity.org, United States of America*	Creating Content Cups This talk will briefly chronicle the mathematical free association that led to the author's exchange gift, highlighting the remarkable extra freedom available in the proof of a pleasant and familiar volume sum formula.	*(TBA)*
Peter Winkler *Dartmouth College*	Puzzles that Solve Themselves Sometimes, even a difficult-looking mathematical puzzle will solve itself if you give it a chance. Following are several examples, mostly with solutions.	*Early Sat PM*
Stephen Wolfram *self*	TBA TBA	*Late Thu PM*
Colin Wright *self*	Thirteen - Insufficiently Maligned	*Early Fri AM*
Carolyn Yackel *Mercer University, United States of America*	Enough Lace Patterns for Fibonacci I will describe a combinatorial theorem discovered as a consequence of a knitting contest I did not win. Its technically exacting proof was not necessitated by its application for a knitted stole I made, yet it is a surprisingly beautiful result nonetheless.	*Sun AM*