

THE PURCELL SCHOOL PRESENTS

MATHS IS MUSIC . . . MUSIC IS MATHS CELEBRATION CONCERT

WEDNESDAY 11 MAY - 19.00



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WELCOME

The 'Maths is Music . . . Music is Maths' project has been an exciting cross curricular project which we set up to explore the deep links between mathematics and musical creativity. Over the past academic year our students have been able to investigate ideas and areas of maths that can be used as inspiration or as tools to create compositions. Tonight's concert is a celebration of final pieces submitted by our students and the wide variety of themes and instrumentation in the programme is testament to the success of the project and how well students across all year groups have engaged with new and sometimes challenging concepts. We hope you enjoy the concert!

'Incorporating maths and music was a new experience for us, which proved to be very educational and challenging but very exciting, nonetheless. It was a pleasure to work with the creators of such a unique composition. We all really enjoyed the workshop and the innovative ideas shared with us.'

> Jennifer Baek, Ava Brule-Walker, Henrietta Dalgleish and Shlomo Levy Year 12 String Quartet

Alexandra Stone Head of Maths



INTRODUCTION

MATHS IS MUSIC . . . MUSIC IS MATHS WORKSHOP

On Wednesday 2nd March 2022, a unique workshop took place at The Purcell School which bore witness to the remarkable relationship between maths and music. The event was part of the groundbreaking and ambitious project entitled 'Maths is Music . . . Music is Maths', which was conceived by Head of Maths **Alexandra Stone** and became a collaboration between the Royal Northern College of Music's Centre of Practice and Research in Science and Music (PRiSM) and The Purcell School's own Maths and Composition Departments.

To explore the links between maths and music, famed mathematician **Marcus du Sautoy** and contemporary composer **Emily Howard** led a day of workshops and high level discussions about advanced mathematical and philosophical ideas which, in turn, inspired the creation of many original compositions with maths unequivocally at their heart.

Over 50 students attended the day and explored some challenging ideas with live performers. Much of this evening's performance of new music has come from ideas presented in the workshop – from geometrical shapes and numerical series, to proofs and conjectures – and we are delighted to welcome back **Emily** and **Marcus** this evening to hear the final pieces.







'This workshop has helped me see the connection between maths and music as I have never really looked at these subjects in this way before. Now I see them as very much connected and I feel the day has helped me in both subjects as well as my musical composition skills. The range of questions asked really made me think about how maths is in everything.'

Celeste Bolmat, Year 8

INTRODUCTION

WORKSHOP HOSTS



MARCUS DU SAUTOY

The Simonyi Professor at Oxford University and Director of PRiSM

simonyi.ox.ac.uk

Professor Marcus du Sautoy is widely known for his work to popularise mathematics. He appears regularly in the media and has written numerous academic articles and popular books on mathematics. He gave the Royal Institution Christmas Lecture in 2006.

His research interests include understanding the world of symmetry using zeta functions, a classical tool from number theory. His work uses a wide range of methods including p-adic Lie groups, model theory, algebraic geometry and analytic methods. (He is also a trumpeter himself!).



EMILY HOWARD

Professor of Composition at RNCM and Director of PRiSM

emilyhoward.com

Emily Howard's distinctive music is notable for its granular use of instrumental colour, powerful word-setting and inventive connections with mathematical shapes and processes. Recent compositions include a series of orchestral pieces inspired by geometric objects, commissioned by the Barbican for the London Symphony Orchestra.









TEN

KAELAN BRYDEN-JOHNSON Flute, clarinet, piano, bass, drums

'My piece was inspired by number bonds. I thought of a random number, of which I chose the number 10, and then I thought of pairs of numbers which added to make 10. I used these numbers in pairs of time signatures that add up to 10/4. These time signatures gave my piece a unique quality, and the constant change in the pairs I used made the piece stay interesting.'



SOBCZAK NUMBERS

APRIL SOBCZAK Piano solo

'I have coded the numbers into notes: 0Eb 1F 2G 3Ab 4Bb 5C 6D 7Eb 8F 9G

So this piece is in Eb major, in 2/4.

The reason the number goes until 9 is because I have coded my family date of birth with these notes and the highest number is 9, and for two digit numbers, like 10, you would use 1F and 0Eb and the tune would then be F-Eb.

It starts with my birthday, 26/2/2009, and ends with my Dad's, 18/10/1979, and the individual code sits mainly in the left hand while the right hand does something interesting. The reason all the rhythms are simple is because the numbers too are quite simple themselves, if 2+2 = 4 then it never changes, and this is the same in this music. There is a bar rest before the next person's birthday so you can tell when we move on to the next person and there are four birthdays in total. At the end all of them are put into one jumble and I bring an old tune back from my last piece in Comp Comp and the piece ends on the mediant which I don't think is very common, but this piece is not meant to be common.'



Programme notes written by Kaelan Bryden-Johnson and April Sobczak

FIBONACCI SEQUENCE

LUCA NEWMAN Trio for violin, cello

'My maths/music piece is based around the Fibonacci Sequence. All the notes are written using the number or a multiple of it. It sounds more modern and dissonant than the sort of music I usually write but I enjoyed writing it.'

20 MOTIFS OF PI COLE LAM

Violin, piano 'My piece is inspired by the digits of pi because I once recited 100 digits of pi from memory to

I once recited 100 digits of pi from memory to a tune. I used each different digit and created a short motif for each one and put it into a piece with a recurring ostinato, hence the name 20 Motifs of Pi. My personal favourite was 5, where I play along with my left hand ostinato in two hands as shown in the extract. It was very interesting how well the piece works together since I overlap some of the motifs in places where the order of digits goes something like '141' or '535' as some of the motifs that I created with the certain numbers work well when played at the same time.'

PRIME

MADDIE MELVILLE-SMITH Solo piano

'My composition *Prime* is inspired by two mathematical ideas, the first (as predicted by the title) prime numbers, and the second symmetry. I used the prime numbers to control my rhythmic values, and this was really interesting because it gave the piece a rather unpredictable feel which juxtaposes the reliability of pitches based on symmetry. This symmetry is centred around the D above middle C - the literal mirror line of the piano, but this is revealed gradually throughout the piece, with the pitch choices initially seeming random. Through doing this, I really enjoyed exploring how the symmetry created both incredibly dissonant intervals, but also perfect 5ths and octaves, and the relationships between these when approached in an order moving outwards from D, across the whole range of the piano.'

HIDDEN PARALLELS

FRANCESCA STEVENSON Piano solo

'I wrote this piece originally thinking of the shape of a seventh chord arpeggio and how I liked the sound world it created. I then began plotting the shapes on a graph and realised that the same arpeggio in a different inversion created two parallel lines - hence the name *Hidden Parallels*, where the two motifs, both melodic and arpeggiated, ironically end up meeting. I really hope you like it as much as I enjoyed writing it.'



Programme notes written by Luca Newman, Cole Lam, Maddie Melville-Smith and Francesca Stevenson

THE STUPID EXISTENCE OF ROMAN OPOLKA CONNOR COX Creative Ensemble group

'Roman Opalka was a painter who decided to take on the impossible challenge of painting the numbers zero to infinity. He started in 1965 and continued until his death in 2011 and got to over 7 million, filling up hundreds of canvases. Roman Opalka described life as a 'stupid existence' and dedicated his life to the absurd. This piece tries to encompass the pointlessness of life and the philosophy of infinity.'

CUBED MIRRORS

ANTONIA ZADRAG Percussionists

'Cubed Mirrors is a piece based on mirrors and symmetry. I chose 6 wood blocks (specifically wooden blocks) at different pitches, in order to focus fully on the rhythmic aspect of the piece, and take that as far as possible. Each part enters at a cubed numbered beat. Part one at 1 beat, Part two at 8 beats, Part three at 27 beats et cetera. There are five main motifs, each which are all symmetrical, and these form something resembling a canon between the parts, as each part plays the themes in the same order when they come in, except the entries are not equidistant. Once the sixth part finishes the first theme, there is a coda in 5/4 time. I chose this time signature because it is symmetrical, and all the blocks are in unison for five bars.'







Programme notes written by Connor Cox and Antonia Zadrag

AXIOM

JOSH GEARING Percussion, voice

'Axiom is a piece that is based on the five Axioms of Euclidean Geometry. Whilst their statements are short and simple, there's a long history behind them. Their strange origins have led to rules in mathematics which cannot be broken at all, even if you try as hard as possible to find a different rule or try proving it wrong! This composition aims to combine the aspect of reading the truths out in a very 'lecture-esque' way, with the percussion breaking the bounds of what is considered possible, with 13 instruments and two hands to one player.

This piece is also one that I'm sure will have some quite familiar aspects if you know Xenakis really well - he was a big inspiration on writing this work, and especially as the majority of his work was in engineering and composing with mathematics, it only made sense to have him be one of my major influences whilst writing this.

A lot of mathematical ideas and processes went into this, particularly my fascination with sequences, palindromes, mirroring (treating notes as dots on a graph and finding their inverse) and even finding uses of functions. Despite the use of maths and strict time frames in this peculiar universe I have created, the music must also have a light-hearted quality, and really sing out through the instruments - particularly in the voice. It has to seem like it wants to be locked in a box of strict scientific-like truths, when actually the exploration of rhythm and sound in general should give the piece a more comedic quality. The dialogue between the two ideas in the fourth statement should be really dramatic and burlesque-like: there is still mathematics at work here, but it should almost seem like an argument is taking place.'

HEBRIDEAN SHORES

PHOEBE PAPANDREA Flute, violin, piano, harp, timpani, cello

'The Golden Ratio, also known as phi, was the starting point for my composition *Hebridean* Shores. The Golden Ratio is a mathematical ratio found in all of nature. Across the ages man has used the ratio in art and architecture and is also found embedded in the harmony and structure of music. Mozart used it in his compositions and Leonardo da Vinci in his paintings. The idea of finding a pattern of music that achieved both the Golden Ratio 1.618 and repetition combined with the beauty of an ocean wave made me think of the possibilities of linking music and maths with the natural world, the universe and everything. The composition starts with the timpani setting a repetitive rhythm that consists of one crotchet followed by two semi-guavers created by halving the crotchet beat. The cello, piano and harp join the timpani after two bars and enrich the harmony. The melody is picked up by the flute and then violin where the music blossoms with natural embellishments like seashells and the continuous triplets symbolise the repetitive breaking waves on the shore. The harp and piano melodies mirror each other and they are likewise reflected in both the flute and the violin. The music spirals around the key centre until an intentional modulation up a tone at a crucial point in relation to the golden ratio of the total bar numbers and then returns back down like the rise and fall of the tide. The rhythmic beating of the timpani echos the ancient 'waulking songs' from the outer Hebrides and the dotted rhythms picked up in the violin, flute and cello circle around one another to create a feeling of infinity with no beginning and no end just like the universe. The golden ratio then becomes not just a mathematical formula for music and art but mathematical proof of natural perfection. The composition concludes how it started with the timpani sounding on its own and fading away to the end.'

THE PI JUNGLE YULIN PAN Hulusi, cello, piano

'My piece was inspired by pi and the randomness of the numbers. It gives my piece a sort of turning point into different passages and explores through lots of different moods. I will be playing the hulusi, a Chinese traditional instrument. I thought of using it because the sheet music is based on numbers and the unique sound of the instrument will make it sound interesting and will contrast with the cello and piano. This piece is set in a junglelike mood and will start with a peaceful morning.'



CLOSER

AMANDA ZHOU Oboe, viola

'Originally, I thought about writing a piece inspired by geometry but as I learnt about iteration and binomial expansion, and how some sequences diverge while others converge, I was amazed by the infinite terms, and how they gradually converge to the 'true' number.

Written for viola and oboe and titled Closer, I aim to transpose this mathematical phenomenon into musical context, while exploring the unusual combination of instruments. With the structure resembling 'theme and variation', it's however reversed with several variations played first, then the 'real theme' presented at last. This is to mimic the sequential terms that converge to the real number, with variations that alternate between major and minor keys that represent the forward and backward convergence. As mathematically the terms get closer to the real answer, the variations also become more similar to the real theme. Hence the title Closer.'

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QUARTET FOR THE END OF THE DAY

EDWARD TAIT Electronic

'This electronic composition was partly inspired by a composition seminar with composer Robert Saxton, about the use of isorhythms in Messiaen's Quartet for the End of Time, which also inspired the title of my piece. The piece also uses isorhythms; a technique that repeats a melodic pattern (known as the 'color') and a rhythmic pattern (known as the 'talea') at different rates, so that they intersect at different points after each repetition. In this piece, I have used a 33-note color (which is also partly serialist, as it repeats each note of the scale in a repeated order) and a nine-note talea, lasting three bars long. As a result of the isorhythm's length, the color and talea intersect after the end point of the piece itself, creating a feeling of endless time.

Underpinning the isorhythm, the talea, on its own, repeats throughout the whole piece, being passed between multiple different instruments. Everything else in the piece is, in some form, related to this melodic and rhythmic material.'



RIEMP SUNBERM

PATCHUBUN PANJAMAPIROM Two pianos

'This piece is called *Riemp Sunberm* and it is about prime numbers but I wouldn't name it prime numbers because that would be simple. In the piece you will hear two piano parts and each part does different jobs. For example one part plays every two bars and some part plays every seven bars because these numbers are prime numbers! This piece has a metronome mark which is also a prime number and in each bar of the piece there are accents that make an accent on every note that is a prime number 2,3,5 and 7. And there is a second movement that is a slow part and it is very slow because the metronome mark is 17 which is also a prime number and in the second movement, the notes you will hear are also the notes that are calculated and they are prime numbers!'

VIOLIN SONATA

PHILIP THEODOROU Violin, piano

'Sonata for Violin and Piano is currently the first three movements for what will hopefully become a five-movement work. The sonata explores the idea of symmetry as a means to portray a lonely character standing upon an expansive and reflective landscape, inspired by the salt lakes in Bolivia. It follows a narrative about the figure getting lost in reflection, and then their struggle to get back (though the latter is for the yet to be composed fourth and fifth movements). Asymmetrical symmetry versus true symmetry is the centre most element to the work, with only one theme in the sonata ever being presented as true symmetry. The idea of symmetry is constantly explored melodically and rhythmically via retrogrades and inversions; but also structurally, most notably in the second movement which is palindromic. In this way, the work uses maths not only as compositional inspiration, but also to cohere the ideas of the narrative with the music.'

ACKNOWLEDGEMENTS

Ongoing sponsorship and financial support is crucial to The Purcell School maintaining its role as a world renowned centre of excellence for the education of young musicians.

If you would like to make a contribution to the School, please contact the Development Department at development@purcell-school.org or visit www.purcell-school.org/donate-now.

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