Exploring Art and Mathematics

The Queen’s College Oxford Project
2005

Exploring Art and Mathematics

Seminar and Workshop

Dr Ulrich Grevsmühl

and the artists

John Carter
Michael Kidner
Jo Niemeyer
Peter Randall-Page
Gary Woodley

The Queen's College Oxford

Saturday 9th April 2005

Programme

9.30am: registration with coffee/tea in the Memorial Room

10am - 11.30pm: Golden Section / Golden Angle and applications in the following topics:

- Jo Niemeyer and his land-art project OXFORD2OXFORD
- Michael Kidner and his works using Penrose tiling
- Peter Randall-Page and his works using Phyllotaxis and Geodesic domes

11.30am - 12am: workshop session 1

- workshop C in the FQ lecture room C: Geodesic domes
- workshop F in the FQ Foyer: Penrose tiling
- workshop G in the Provost's Garden: land-art project

12am - 12.45pm: workshop session 2

- workshop C in the FQ lecture room C: Geodesic domes
- workshop F in the FQ Foyer: Penrose tiling
- workshop G in the Provost's Garden: land-art project

12.45pm - 1.45pm: Lunch in the Dining Hall

1.45pm - 3pm: Geometric shapes, solids and surfaces and applications in the following topics:

- Gary Woodley and 3D-surfaces and projection methods
- John Carter and geometric aspects and aesthetics in his works

3pm - 3.30pm: workshop session 3

- workshop A in the FQ lecture room A: video presentation, 3D models and geometric problems
- workshop B in the BQ lecture room B: soap film experiments, 3D surfaces and projection methods
- workshop C in the FQ lecture room C: Geodesic domes (cont.)
- workshop F in the FQ Foyer: Penrose tiling (cont.)

3.30pm – 4.15pm: workshop session 4

- workshop A in the FQ lecture room A: video presentation, 3D models and geometric problems
- workshop B in the BQ lecture room B: soap film experiments, 3D surfaces and projection methods
- workshop C in the FQ lecture room C: Geodesic domes (cont.)
- workshop F in the FQ Foyer: Penrose tiling (cont.)

4.15pm - 4.30pm: coffee/tea break in the Memorial Room
4.30pm – 5.30pm: we conclude the day with a general discussion.

Ulrich Grevsmühl

A summary of the event

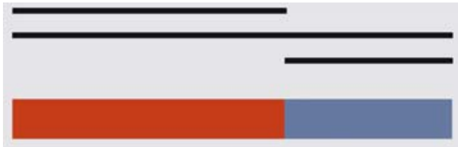
A contribution to the cultural programme was made on April 9th, 2005 when an interdisciplinary one-day seminar and workshop on Modern Art and Mathematics was hosted in the superb surroundings of The Queen's College Oxford.

Ulrich Grevsmühl, who is an Old Member of Queen's and who now works as a mathematics educator and physicist at the University of Education in Freiburg, Germany, had devised the day and brought together five out-standing and internationally well-known artists in an inspiring and unforgettable event. After his introductory lecture Dr. Grevsmühl led the audience through the stimulating discussions, workshops and activities which revolved around the central theme ***measure and measurements*** with applications of the Golden Section to land-art, aperiodic tilings, phyllotaxis and geodesic domes. The afternoon sessions focused on soap film experiments, minimal surfaces and activities in mental geometry.

The artists from left to right: Gary Woodley, Peter Randall-Page, John Carter, Michael Kidner (sitting), Jo Niemeyer.
On the right: Ulrich Grevsmühl

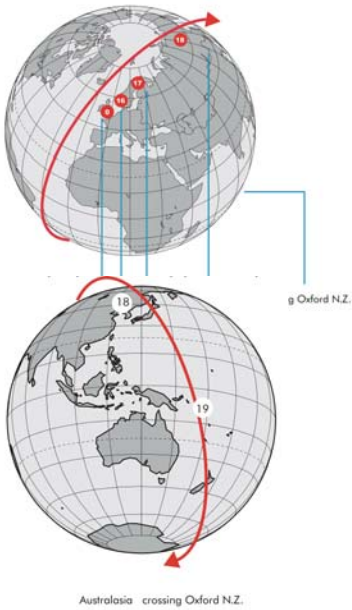
Jo Niemeyer

German artist Jo Niemeyer has been working in constructive-concrete art since 1970 and in land-art since 1988. At Queen's he created the land-art installation *Oxford2Oxford* which is based on the following problem:



Look at this series of five red dots on the left of this page. Imagine now you continue this series and go round the earth once to reach the starting point again. How many further steps will you need?

Taking the Golden Section as a means to measure Niemeyer has created a vast number of works where he investigated the properties and interrelations of measures. The Golden Section may be defined by the double ratio: A line segment is divided according to the Golden Section when the whole length is related to the larger part (major) as the larger part to the smaller one (minor).

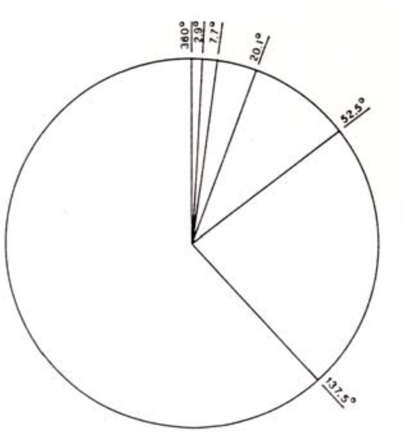


For his land-art installations Jo Niemeyer formulates his problem in the following way:

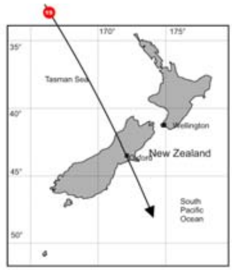
Divide the circumference of the earth by the Golden Section. Then divide the minor again by the Golden Section and repeat this process of dividing for each newly generated minor down to distances of a few centimeters. Mark each of the dividing points by a rod on the earth surface or by a point on the drawing paper. By repeated application of this algorithm a series of rods are generated on the earth surface with distances becoming increasingly smaller and being finally proceeded on paper by the series of dots depicted here.

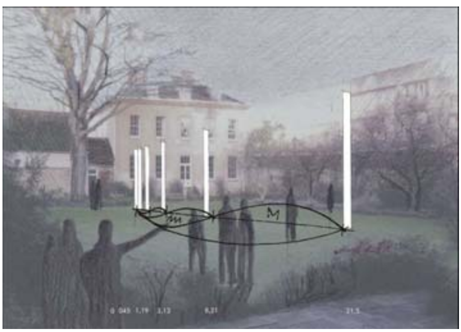
Indeed the first rod outside of the paper is about 45 cm away from the first dot depicted on the bottom left of this page, the further ones are at about 1.2 m, 3.1 m, 8.2 m, 21.5 m, 56.3 m, and so on. The 20th rod finally leads back to the starting point of the series completing the circle of about 40 024 km around the earth: **in 20 steps around the globe.**

This project had started more than 15 years ago as a joint effort between the artist and Dr. Ulrich Grevsmühl who had calculated the initial mathematical problem using spherical trigonometry and the Golden Angle.



The algorithm cited above for calculating the points of series is not sufficient to carry out concrete geodetic calculations. For the mathematical formulation of the problem one has to take into account that every route around the earth is a natural fractal. As a result of the topography of the earth the circumference of the earth becomes longer the smaller the scale is by which we measure whereas the enclosed area is limited and remains finite. Consequently, the actual circumference of the earth is in principle not suitable for a mathematically exact formulation of the problem. Rather a method independent of the circumference of the earth has to be found. The division of angles of the full circle is a way out. Applying the golden section to the full circle in degrees gives us the Golden Angle ϕ_m = 137.5...° Repeated application of the Golden Section to each newly generated minor in the division process provides the increasing elements of the minors series in degrees.





For the Oxford project Niemeyer was inspired by the extraordinary journey by Joanne Bowlt and Tim Nicholson who drove from Oxford UK to Oxford NZ in a Morris Oxford (for details of their project we refer to www.oxford2oxford.co.uk). Indeed the Oxford installation in the Provost's Garden in the Queen's College consisted of a series of white poles that invited the spectator to a journey around the earth in just 20 steps, starting and ending in Oxford UK and passing Oxford in NZ.

Niemeyer says: *Neither the artist nor the audience can ever see this project in its total. But this point is not debatable. It is not the point to see more or less but to perceive the world in a new and different way. '20 steps around the globe…' means a mythological journey which are two things: an adventure and an interdisciplinary expedition into no-man's land between the borders of science, philosophy and religion. It is mainly this principle of crossing the boarders which holds the experimental charm of this project.*

Oxford2Oford: in 20 steps around the globe… land-art project
installation in the Provost's Garden of The Queen's College Oxford 2005

At Queen's Niemeyer installed the first 6 steps over a distance of 21 meters in the Provost's Garden where his installation amazed by its simplicity, harmony and beauty.
In the workshop videos and computer simulations extended the series of poles to the boundaries of the earth and indeed to macro and micro cosmos. Further activities included the construction of a regular pentagon by simply tying a knot and the building of a regular icosahedron by using three orthogonally placed Golden Rectangles.

Michael Kidner

Applications of the Golden Section to tilings were dealt with in the workshop under the direction of London based artist Michael Kidner. Kidner employs the systematic approach, the constructive investigation both for creating and developing new ideas and making his works more comprehensible. His vast areas of work range from drawings and paintings to sculpture and installations combining the elements of rationality and feeling, order and beauty. Kidner states:

The order in a painting refers to a much larger concept of order outside the painting. The order in mathematics refers to an order we perceive in the cosmos. ... the painter may think of himself as creating order, as discovering order, or as observing order.

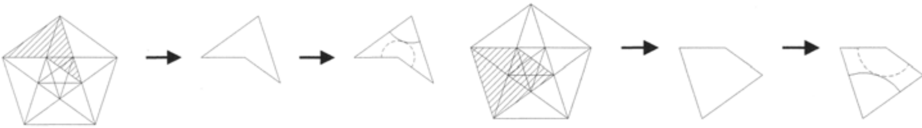
A tiling consists out of a set of tiles, called prototiles, which cover the plane without gaps or coverlaps. The tiles can all have the same shape or they consists out of a number of different shapes. Many tilings by regular polygons, e.g. equilateral triangles, squares, regular hexagons, are well known and were the first kinds of tilings to be the subject of mathematical research. In particular many findings go back to the pioneer work of Johannes Kepler, a 17th century German Astronomer who lived in Weil der Stadt near Stuttgart. All these examples of tilings are **periodic** as it is possible to take a suitable part of the tiling and generate the whole tiling by means of translations. On the other hand, a tiling is called **aperiodic** when it is not possible generate the whole tiling by means of translations.

One of the most remarkable discoveries in the theory of tilings has taken place during the last 30 years. It concerns the existence of sets of prototiles which admit infinitely many aperiodic tilings of the plane. In 1973 and 1974 **Roger Penrose** discovered in Oxford three sets of aperiodic prototiles which are all derived from the regular pentagon and with each set having to satisfy certain matching conditions for the edges. Without these matching conditions for the edges, the tiles of the Penrose sets would admit simple periodic tilings.

In some of his more recent works Michael Kidner has used the three sets of aperiodic prototiles by Roger Penrose as a foundation for his various colour constructions that he applies in his drawings and paintings.

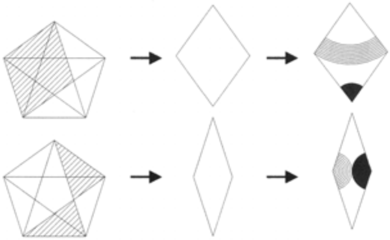
In the workshop the participants engaged in trying out the different sets of Penrose tilings while Kidner outlined the artistic impetus and implications of his works.

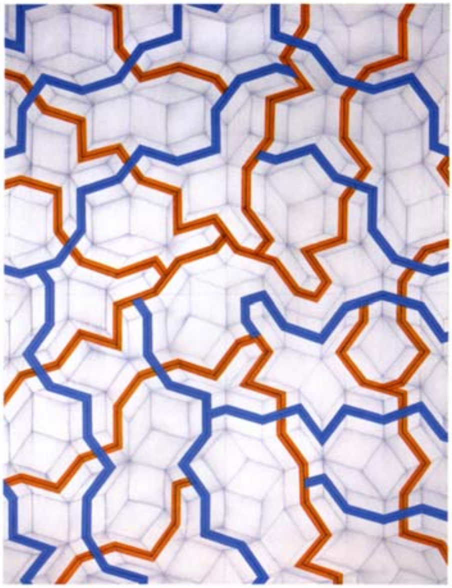
Roger Penrose Aperiodic Prototilings Set using kites and darts:



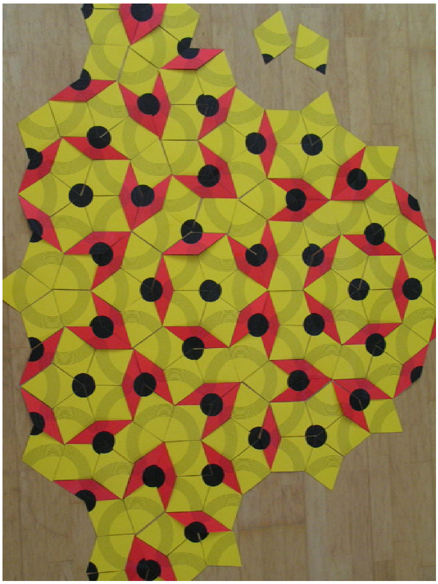
Lilipond
tulle cardboard and acrylic on board 244 x 366 cm, 1999

Roger Penrose Aperiodic Prototilings Set using two different types of rhombs:

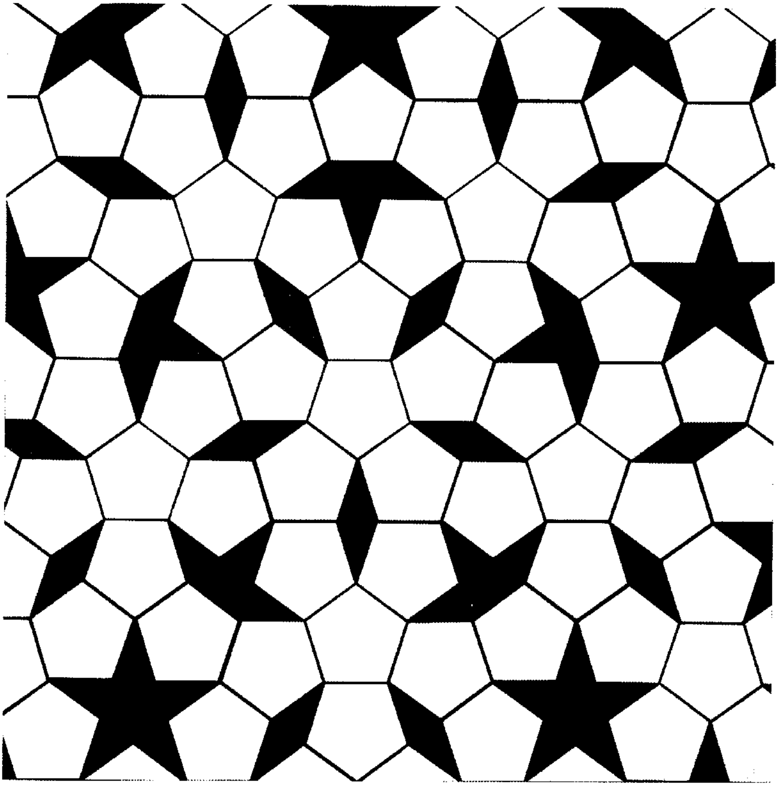




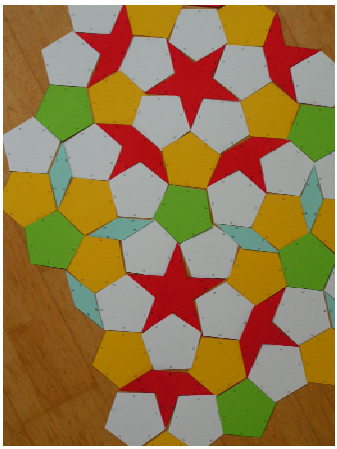
Crossroads
acrylic on board 135 x 102 cm, 2001



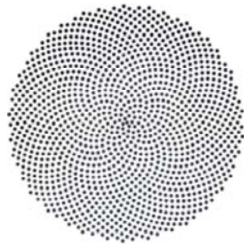
Roger Penrose Aperiodic Prototilings Set using pentacles, half-pentacles, rhombs and three different types of pentagons:



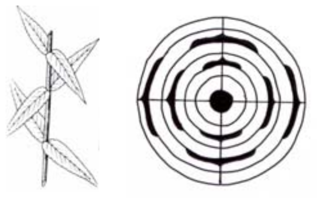
The Emperors New Mind No 2 acrylic on board 100 x 100 cm, 1995



Peter Randall-Page

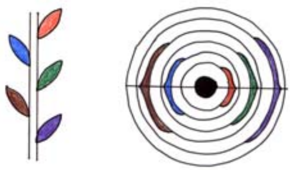


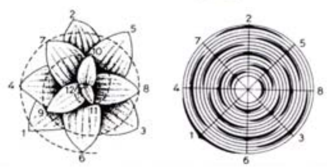
The themes of the Golden Angle and of the Fibonacci numbers were carried further in the work of the artist and sculptor Peter Randall-Page from Devon who has investigated in great depth the structures of organic growth and the patterns that occur in living nature. One of the few scientifically proven cases where the Golden Section occurs in living nature is phyllotaxis where the arrangement of leaves in plants are analysed. Here we find impressive examples of the occurrence of rational as well as irrational proportions.



Vegetative shoots have different forms of positioning the leaves. Shoots with whorled positions of the leaves are for instance characterised by two or more leaves situated on one node and are found in clover, lilac and the frond of the fir-tree. The angle between two successive leaves are therefore factors of 360° and thus rational.

In contrast to this the helicoid arrangement differs in such a way that each node carries only one leaf. Here the leaves are all distributed in helicoid arrangement around the stem. Between each leaf and its predecessor there is a certain, usually constant angle which is known as the **angle of divergence**. In the simplest case one finds shoots with a distichous arrangement of leaves where the leaves are arranged alternatively alongside the shoot axis in only two lines facing each other. For this arrangement of leaves the divergence takes an angle of 180°, as it occurs for instance in the monocots, and is therefore called orthodistichy.



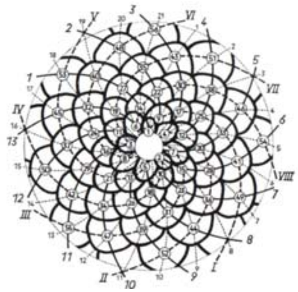


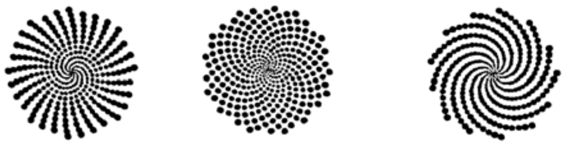
For many monocots with distichous arrangement of leaves, however, a striking tendency towards a spiral movement can be observed. The leaf primordia at the growing points occur here in two screw-like lines wound in the same direction which is also called spirodistichy.

In phyllotaxis it is not customary to state the divergence as part of the circumference of the circle. The numerator of the fraction of divergence is found by the number of circulations which are necessary in order to reach the next following leaf in the same straight line above. The denominator states the number of leaves in between. The empirically found fractions of divergence are obtained by the so-called Schimper-Braun main series.

$$\frac{1}{2} \quad \frac{1}{3} \quad \frac{2}{5} \quad \frac{3}{8} \quad \frac{5}{13} \quad \frac{8}{21} \quad \frac{13}{34} \quad \frac{21}{55} \quad \frac{34}{89} \quad \dots$$

In recent times a more precise analysis of the angles between the leaf primordia on the stem axes has shown that all higher divergences can be traced back to the Golden Section where, because of its irrationality, a newly formed leaf is theoretically never exactly situated above an already existing one by which optimal use is made of the incidence of light. Consequently, with the numbers of primordia and of circulations increasing a number of oblique lines curved to the right and to the left, so-called parastichies, become visible. This for instance becomes clear in the fir-cone, the pineapple and the inflorescences of composites like sun-flower, thistle, dandelion, margarite and daisy where the adjacent leaf organs exhibit a broad contact area.





The structures of leaf arrangements can be investigated by computer generated graphics. In order to simulate the generative principle of the spiral positioning of the leaves the polar coordinates of a blossom are recursively being calculated by the preceding blossom where radius and angle of divergence increase by the same amount, respectively. The three computer graphics above show three receptacles with angles of divergence of 136.5°, 137.5°, 138.0° (from left to right). This reveals that parastichies curve to the right as well as to the left occur only when the value of angle of divergence reaches the Golden Angle.

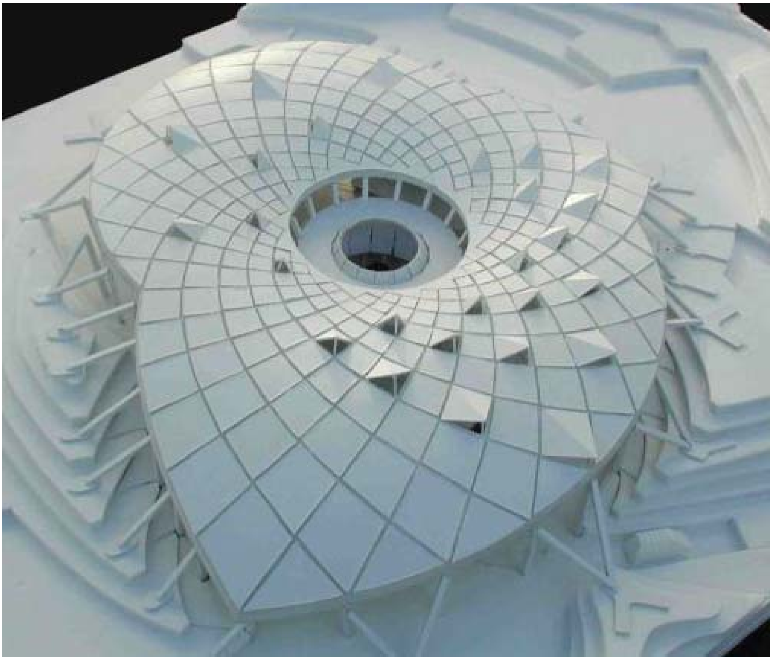
IIMW, 120 x 170 x 100cm, 2004

Give and Take
345(high)x295x261 cm,
granite, 36 tonnes, 2003

Multiplication by division 105x105x105cm (each), Guiting limestone, 2000

Peter Randall-Page has been fascinated by the role mathematics and in particular geometry plays in nature. He states:
In the real world one never sees the geometry that underlies growth in a pure and perfect state. Nature adapts to local conditions. Over the last twenty five years my practice as a sculptor has taken me on a journey from simple observation of natural phenomena towards an investigation of the mathematical and geometric principles and dynamics that underlie the forms we see in nature. Geometry appears to be the theme on which nature plays almost infinite variations.

Eden project 2005



In his very informative and impressive talk Randall-Page gave an insight into the development of his work with special emphasis on his latest monumental Eden project. Talking about his work he described the problems of mapping the surface of a given, random boulder with a geometric structure and its implications to the geometry employed. He also discussed some of the technical and mathematical procedures that arise in the process of carving the sculptures and in projecting the genetic helix onto pieces of stone.

In the workshop the participants enjoyed analysing various forms of leaf arrangements from plants found in the Botanical Gardens and on Christ Church meadow and traced the Golden Angle in the spiral arrangements of fir-cones, sunflowers, thistles and so on. Finally, a constructional activity was set where different types of geodesic domes had to be made from cardboard.

Gary Woodley

The afternoon section started with the work of Gary Woodley and led us on an exciting journey to mathematical surfaces and soap film experiments. The following problem was given to me by Gary Woodley some time ago which I have been employing since in my geometry seminars as an investigational activity for my students:

- Choose a room which has more or less the shape of a cuboid, a lecture room is usually ideal for that. Find the volume of this room.
- Determine its centre point in space by intersecting the diagonals and mark it, for instance, by the end of a rod fixed onto a table.
- Attach a string to the centre point of variable length and place a piece of chalk or marker at its end. Find the radius of the sphere which has a volume equal to that of the room.
- Draw the intersecting line of that sphere with the floor, ceiling and walls of the room and mark it with coloured tape.
- Investigate the effects on the intersecting line when the radius is decreased or increased and record your results by drawings.
- Now change the position of your centre point and see what happens.

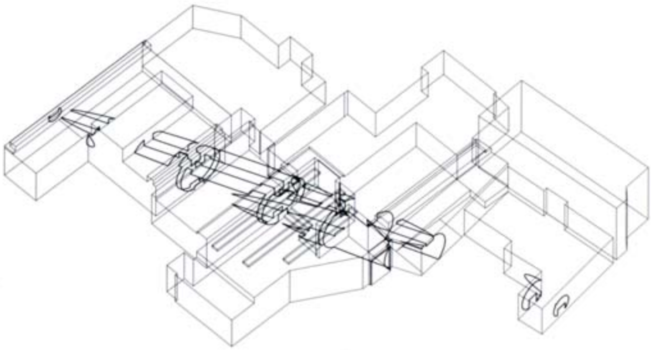
Impingement No.4: Sphere with a volume equal to that of the room
Exhibiting Space, London, 1985.

Woodley is a constructivist who has a strong interest in mathematical shapes and surfaces and in methods of projection. Carrying out experiments with soap films and geometric shapes he became fascinated by the immaterial of geometrical concepts. He says:
I like the feeling that the work is really the trace of something that has been removed. The geometry that is passing, slipping through.

The ‘trade mark’ of the artist Gary Woodley from London are his ***impingements***. An important theme which runs throughout his impingement works is therefore the visualisation of intersections of ideal solids, such as spheres and ellipsoids, with the physical reality of an interior or exterior environment which he describes as ***intersections of material with immaterial***. Often his works are large-scale 3-D drawings performed in more or less empty rooms and outdoor sites with drawings with tape and electro-luminescent strips or just soft crayon. They can serve as starters for a number of intriguing investigations in three-dimensional space.

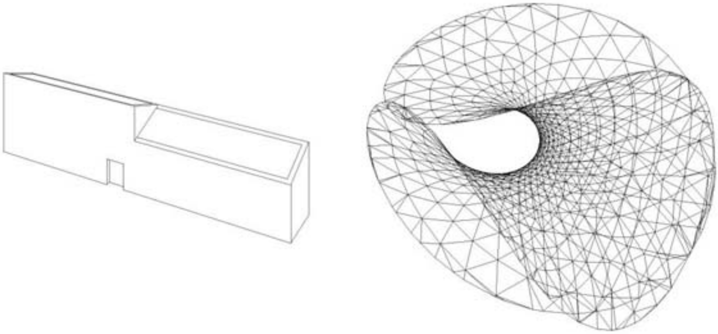
Gary Woodley is also very keen in the technical side and has acquired a sophisticated know-how. He has developed his own methods of drawing and his own drawing tools for carrying out his sculptural constructions in the environment. In his earlier works he designed a pointing jig with flexible arms which enables him to draw regular curves, such as circles and ellipses, onto environmental surfaces and other irregular boundaries, very often with the use of a laser beam. In fact his work lives and grows naturally from his technical interests. The construction of his drawing tools is in many ways continuous with his sculptural constructions and environmental configurations.

.

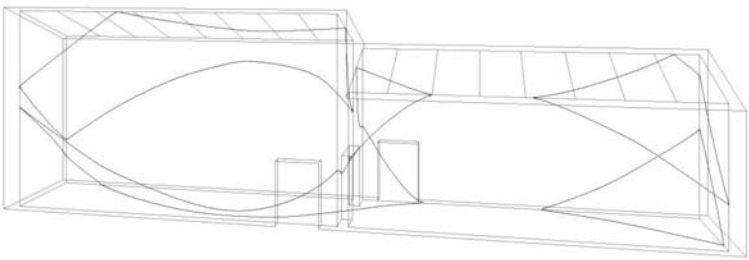


Impingement no 42: Ellipsoid with pair of parallel ramped notches
Intersection of an ellipsoid with a whole building: Kettle's Yard, Cambridge, 2002, Computer Drawing and detail

Recently Gary Woodley has employed the computer for 3-D scanning of the environment (whole building or part of it) and 3-D modelling. This has not only opened up for him a whole range of almost endless possibilities but also enabled him to use complex shapes and surfaces, like Enneper's and Schwarz's minimal surfaces.

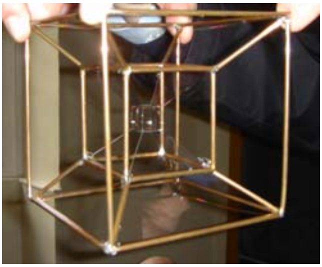


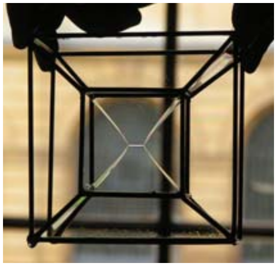
Hombroich E drawing schematic: Enneper's surface, 2004



Hombroich E drawing 2c: intersecting Enneper's surface, 2004

In the workshop the participants were fascinated by the investigation of soap film geometry which revealed an insight into the properties and aesthetics of soap bubbles and soap films and to minimal surfaces. A special soap solution and various wire and rubber frames were used to ensure a prolonged stability of the soap films.

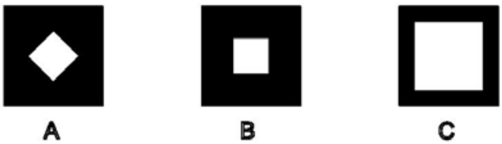




John Carter

The afternoon session of the seminar focused on various activities dealing with fundamental geometrical problems The concrete artist John Carter from London is today well known for his wall-objects and architectural sculptures. Many of his works arise from investigations into fundamental mathematical concepts like the equivalence of area which he often combines with transformations of basic geometrical shapes and forms. His work is therefore an appeal to our imagination, to our creativity and an invitation to discover the underlying principles of his work.

As an introduction to his work try the following **paper folding task**:
Start with a square piece of paper. Now fold the paper and cut out a smaller square with one single straight cut to produce one of the following results. In fig. A and fig. B the size of the smaller square is arbitrary but in fig. C the smaller square has the same area as the surrounding boarder.



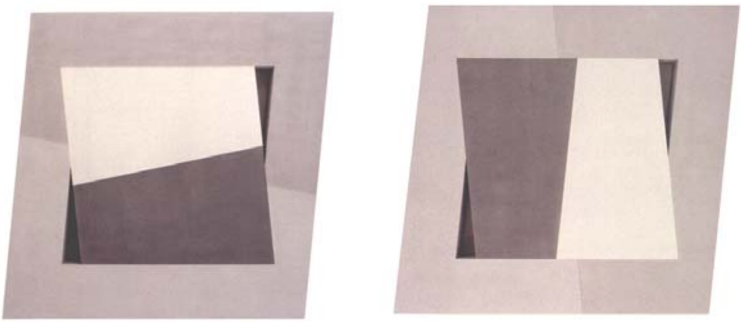
At the beginning of the 80s John Carter began a work period which he has called the **Equal Areas** theme. In this he investigated in great depth the concept of **equivalence of area** which was applied amongst other shapes also to the square.

Painted Structure: Squares, oil on plywood, 21.5x34x21 cm, 1983

Characteristic for this and other of his works, the spectator is invited to carry out his or her own investigations and to perform in the head some exercises in **mental geometry**: Indeed the work here is based on fig. C of the paper folding task above where the area of the large square is twice as big as the area of the cut-out smaller square.

From 1987 onwards we find works which deal with the superimposition of two identically divided parallelograms with resulting asymmetries These works create tension, catch the attention of the spectator and ask for interpretation. The artist does not stay in the plane but gives more weight to the form by translating it into 3-D. Typical for Carter is the representation as a cut-out, as a boundary section or as a wall object. Carter enhances the sculptural effect by covering the surface of his plywood objects with a mixture of acrylic binder, marble powder and pigment which are then sanded-down.

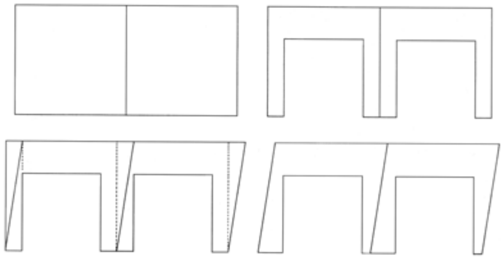
Superimposed Elements in a Square III,
acrylic with marble powder on board, 100 x 100 cm, 1989



Superimposed Parallelograms: Horizontal and Vertical Division
acrylic with marble powder on plywood, 99.5x110x17.5 cm each, 1990

Through the process of visualization the activity of cutting-out a solid is repeated in a dynamic way. The small gaps of triangles have the same visual strength as the shape from which they were removed. In this way the representation unites action and form. By showing only the most essential and basic parts the visualization mediates at the same time IN-SIGHT and OVER-VIEW. We are invited to repeat in our mind the actions that were physically performed before. Our seeing changes from passive to active as our eyes wonder from here to there, feel the shapes, register the arrangements, recognize the orders, relationships, structures and connections.

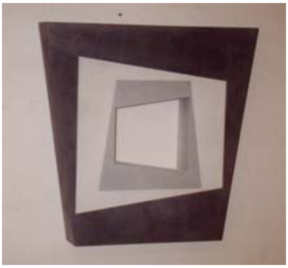
An important landmark in Carter's works is the **Darmstadt Double Arch**. This large scale architectural sculpture was built in the park surrounding the Technical University Darmstadt (TH Lichtwiese) as part of the Symposium "Skulptur und Architektur: Ein Diskurs" in summer 1993.

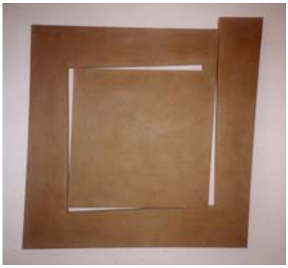


Carter states:
The sculpture takes the form of a double archway. It consists of two parallelogram structures from which two square openings have been cut. Each opening is half the area of each parallelogram. The two parts are joined together in the centre, but appear to lean in opposite directions. An angle taken from the sides of the parallelogram is used for all the angles throughout the work, in conjunction with a vertical.

Darmstadt Double Arch
paint and varnish on plywood, later concrete 366 x 786 x 106 cm, 1993

The Darmstadt Double Arch is related to earlier paintings and wall objects which were realised an a much smaller scale. In many of these works I divided the surface into equal positive and negative areas - like an equation. These areas were determined by exact measurements rather than by eye. A portion, half the area of the whole painting, would be cut out, leaving a frame-like structure. As a consequence the centre of the work became a void and the frame became the "Subject", thus reversing the conventional relation of picture and frame. Although, in actuality, an area of the wall had simply been exposed to view, the act of cutting through the surface of the painting had effectively opened up the structure, allowing the eye to pass through to imaginary Spaces beyond. The next stage was to bring the work down from the wall and let Space pass through it freely. What had been conceived in terms of painting had now become sculpture.





Carter gave a interesting talk on the development of his work over the last 25 years and the audience was puzzled by the tricky tasks in mental geometry and in paper folding.

Gary Woodley, Michael Kidner, Peter Randall-Page, Jo Niemeyer, John Carter and Belinda Cadbury (from left to right)

Published to document the seminar and workshop *Exploring Art and Mathematics* held at The Queen’s College Oxford, 9 April 2005

Organisation of the event: Ulrich Grevsmühl

For further details: www.grevsmuehl.com
email: ulrich@grevsmuehl.de

Speakers Biographies

John Carter

John Carter was born in Hampton Hill, Middlesex, GB. He studied at Twickenham School of Art from 1958 to 1959, then at Kingston School of Art from 1959 to 1963. He was awarded a Leverhulme Travelling Scholarship to Italy in 1963. His first, abstract, constructed works were made during this journey, at the British School at Rome in 1964. On returning to England he worked as an assistant to the sculptor Bryan Kneale. He participated in the "New Generation:1966" exhibition at the Whitechapel Art Gallery, London (also in 1968). He was awarded a Peter Stuyvesant Travel Bursary for the USA in 1966. His first solo exhibition took place at the Redfern Gallery, London, in 1968 (also in 1971,74,77). An Arts Council of Great Britain Award was given to him in 1977 and an Arts Council Purchase Award in 1979. He received a prize from the Tolly Cobbold/Eastern Arts, 3rd National Exhibition, in 1981. A retrospective exhibition of his work was held at the Warwick Arts Trust, London, in 1983. He continued to exhibit at Nicola Jacobs Gallery, London (1980,83,87,90). In 1986 he participated in the international group exhibition: "Die Ecke" at Galerie Hoffmann, Friedberg, Germany, where he made his first contact with European Concrete and Constructive artists. He has since exhibited widely abroad, mainly in Germany, but also Japan and USA. 1993 saw the realisation of a monumental sculpture at the Technische Universität, Darmstadt. Part-time teaching in art schools formed an important part of his life, though he has recently retired from his last post at Chelsea College of Art and Design. He lives and works in London.

Email: cartcad@west2studios.fsnet.co.uk

Ulrich Grevsmühl

Ulrich Grevsmühl studied Mathematics and Physics at the Universities of Stuttgart and Liverpool. He was awarded a Florey European Scholarship from The Queen's College Oxford and received his doctorate in Theoretical Physics and his P.G.C.E at The University of Oxford in 1976. He has been engaged in various interdisciplinary research projects and has taught in serveral institutions in UK and Germany. One of his interests includes the challenging field of Mathematics and Modern Art and its implications to education. Ulrich has collaborated with many European artists especially from the concrete-constructive group in several projects and interdisciplinary events. Many of his publications deal with the interrelation of Mathematics and Modern Art. He currently holds the position of a senior lecturer in the Institute of Mathematics at the University of Education in Freiburg Germany.

Email: ulrich@grevsmuehl.de
Homepage: www.grevsmuehl.com

Michael Kidner

Michael Kidner was born in 1917 in Kettering, England. He received an honours degree in History and Anthropology at Cambridge University in 1939 and from 1940 to 1946 served in the Canadian Army. He studied art in London and Paris between 1947 and 1953. In 1957, his work was included in Metavisual, Tachiste and Abstract Art in England, the first post-war exhibition of British abstract art. In the 1 960s he was part of the Op Art Movement. He has taught at the Bath Academy of Art, Corsham, Chelsea School of Art and the Slade School of Art, London. Kidner has had a number of one-person exhibitions and group exhibitions including the Serpentine Gallery, London, Museum of Modern Art, New York, Amos Anderson, Helsinki, and the Tate Gallery, London.

Email: mail.kidner@virgin.net

Jo Niemeyer

Jo Niemeyer was born in 1946 in Alf, Germany. He studied Photography in Freiburg, and Visual Arts & Industrial Design at the Institute „Atheneum" in Helsinki. Between 1983 and1986 he taught at the Finnish Academy of Fine Art in Helsinki and made Study trips to India, Nepal China. Since 1970 he has been working as an independent artist in „Constructive-Concrete" Art (Graphics, Paintings, Sculptures and since 1988 has been doing Land-Art projects (20 steps around the globe) in many parts of the world. He has works in the following collections: Stiftung für Konkrete Kunst / Reutlingen, Die Neue Sammlung / München, Stadt Jyväskylä/Finland, MoMa/New York, Bauhaus Archiv Berlin, Museum für Konkrete Kunst Ingolstadt, Wilhelm Hack Museum Ludwigshafen, Museum Pecs, Hungary, Forum Konkrete Kunst Erfurt, Modern Art Museum Huenfeld, Mondriaanhhuis / Amersfoort/NL., Nickle Arts Museum / University of Calgary, IKKP, Archiv + Institut für konkrete Kunst, Rehau Germany and currently at the Museum für Konkrete Kunst Ingolstadt „experiment konkret ", „konstruktive kunst aus baden-württemberg" Landesvertretung Baden-Württemberg, Berlin and „50 carré - un choix sur l'art concrète international" musée de sens (f). He lives and works in Germany, Finland and France.

Email: jo@niemeyer.com
Homepage: www.jo.niemeyer.com

Peter Randall-Page

Peter Randall-Page was born in the UK in 1954 and studied sculpture at Bath Academy of Art (1973-77). During the last 25 years his sculpture, drawings and prints have been exhibited widely in the UK and abroad as well as undertaking numerous large scale commissions. In 1999 he was awarded an Honorary Doctorate of Arts at the University of Plymouth and since 2002 has been an Associate Research Fellow at Dartington College of Arts. Amongst current projects he is a member of the Design Team for the Education Resource Centre at The Eden Project, Cornwall incorporating a huge sculpture within the very core of the building and has just completed a commission for the Gwangju Biennale 2004, South Korea. His work is represented in many public and private collections throughout the world including the Tate Gallery and the British Museum.

Email: contact@peterrandall-page.com
Homepage: www.peterrandall-page.com

Gary Woodley

Gary Woodley was born in 1953. He studied sculpture at Camberwell School of Art, 1973-6 and Chelsea College of Art, 1977-8. He was Junior Fellow in Fine Art at Cardiff College of Art, 1978 and has been an Artist Fellow at Kettles Yard, Cambridge 1996-7. His work involves architectural installations using fibreoptic cable and topological projections onto real and virtual spaces realised through computerised design systems. He has exhibited widely in the UK and Europe. Recent solo shows include' Impingement No.44' Grange House, Guernsey, 'Material - 7 modular furniture works', 'Room for', London, currently on show is 'Impingement No 47' at Chelsea Space, Millbank, London. He is also involved in the design of *Primary Space* a new primary school for Dalry, Scotland, with artist Bruce McLean, architect Will McLean and North Ayrshire County Council architects department.

Email: gary@impingements.demon.co.uk