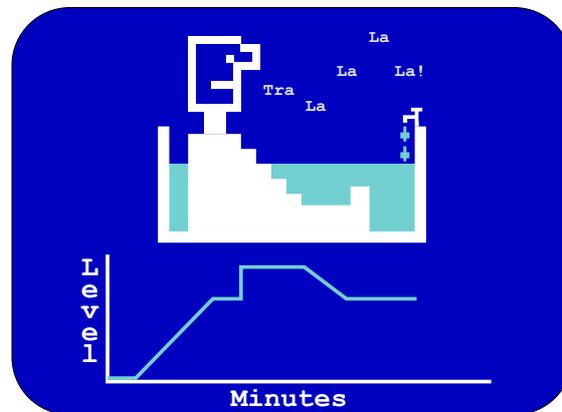


# Shell Centre for Mathematical Education

**1967 – 2017**

Golden Jubilee Conference  
28 – 29 September 2017



Thursday 28 September

# The Shell Centre 1967-2017

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**Exhibition of Shell Centre projects: products and posters**

open from 2 pm

3:30      *Tea*

**The Shell Centre story**

Chair: Geoff Wake

4pm      Opening Welcome

Andy Noyes, Head of the School of Education

4.10      **A brief history of the Shell Centre**

Hugh Burkhardt

4.40      **Design in Mathematics Education - a celebration**

Shell Centre designers will talk on aspects of design and show clips from favourite creations from past and current work by the Centre.

Colin Foster, Rita Crust,  
Daniel Pead, Sheila Evans,  
Clare Dawson, Geoff Wake

5.30      *Reception by the University and the School of Education*

7pm      **Conference dinner**

Friday 29 September

# Impact-focused research – how can it become more effective?

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## Views from the R&D community

Chair: Geoff Wake

|       |   |                        |
|-------|---|------------------------|
| 9 am  | What's the problem?   | <b>Hugh Burkhardt</b>  |
| 9.15  | Moving towards better mathematics education   | <b>Kaye Stacey</b>     |
| 9.45  | The fruits of collaboration<br>or <i>My decade of engagement and 25 years of marriage<br/>to the Shell Centre</i> | <b>Alan Schoenfeld</b> |
| 10.15 | 'To see ourselves as others see us'   | <b>Lynne McClure</b>   |
| 10.45 | <i>Break</i>  |                        |

## What changes in education R&D would impact policy design?

Chair: Hugh Burkhardt

|       |                                     |  |
|-------|-------------------------------------|--|
| 11:00 | Some government advisers' thoughts: |  |
|       | <b>David Laws</b>                   | Education Policy Institute and former Schools Minister |
|       | <b>Alaster Smith</b>                | Department for Education                               |
|       | <b>Paul Black</b>                   | National and international consultant                  |
|       | <b>Neil Carmichael</b>              | former Chair of Education Select Committee             |
| 12:00 | Questions and contributions         |  |
| 12:15 | Summing up:                         |  |
|       | <b>Phil Daro</b>                    | National and international consultant                  |
| 12.30 | <i>Lunch</i>                        |  |

## Thinking through these ideas

Chair: Geoff Wake

|      |                       |
|------|-----------------------|
| 2pm  | Working groups        |
| 3pm  | Summary reports       |
| 3.30 | <i>Close with tea</i> |

# Speakers from the R&D community

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**Geoff Wake** is Professor of Mathematics Education and Director of the Shell Centre team in the University of Nottingham's Centre for Research in Mathematics Education. His 25 years as an academic followed a career teaching in school and college for eleven years. His main area of research and development has involved applications of mathematics and mathematical modelling at all levels, with projects that explored the use of mathematics in workplaces, in transition to STEM courses in university and in the secondary school curriculum. His work has become increasingly international, with contributions to five European projects and more recent partnerships with researchers in Japan and South Africa.

He has designed national qualifications (Freestanding Mathematics Qualifications and A Level Use of Mathematics) to support progression for post-16 students across a range of courses and has been involved in the development of curriculum and assessment for post-16 students in the UK, most recently in the introduction of Core Mathematics qualifications.



**Hugh Burkhardt** was Director of the Shell Centre for Mathematical Education and Professor in the Department of Mathematics at Nottingham from 1976-92. Since then he has led a series of impact-focused research and development projects in the UK and US with strategic, tactical and technical design at their centre. The team were pioneers of engineering research in education through the design and development of tools and processes – an approach based on that in research-based fields like medicine.

For the last decade he has been concerned that education systems rarely look to the R&D community to develop solutions to perceived problems. How that might be changed for the better is the inspiration for this conference - of which he has led the design.

His work has been recognised by an ISDDE Prize for Lifetime Achievement and, with Malcolm Swan, as first recipients of the Emma Castelnuovo Prize of the International Commission on Mathematical Instruction.



**Kaye Stacey** was Foundation Professor of Mathematics Education at the University of Melbourne and is now, among other activities, Director of Special Topics for the Australian Academy of Science's reSolve: Mathematics by Inquiry project. After a doctorate in number theory, she has worked as a researcher, primary and secondary teacher educator, supervisor of graduate research and as an adviser to governments. She has written many practically-oriented books and articles for mathematics teachers as well as creating a large set of research articles.

Her many pioneering contributions to mathematics education included "*The Burwood Box*", a course for student teachers on the teaching of Problem Solving, work on the use of computer-algebra systems in teaching mathematics, and on turning research on student thinking into diagnostic teaching tools through the on-line SMART tests.

She was the Chair of the Mathematics Expert Group for the OECD's 2012 PISA survey. She was awarded a Centenary Medal from the Australian government for outstanding services to mathematical education. Her first visit to the Shell Centre was in 1980.



**Alan Schoenfeld** is the Elizabeth and Edward Conner Professor of Education and Affiliated Professor of Mathematics at the University of California at Berkeley, and Honorary Professor in the School of Education at the University of Nottingham.

He loves math, and learning in general; amazingly, he gets paid to think about these things and help teachers help students develop the same passions. His main work these days is on the Teaching for Robust Understanding (TRU) framework, which helps us focus on what really counts in powerful learning environments. He has worked with the Shell Centre on various collaborative projects since 1982.

His research has been recognised with, among many honours, the Presidency of the American Educational Research Association and the Felix Klein Prize of the International Commission on Mathematical Instruction.



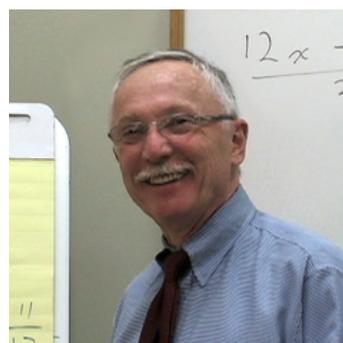
**Lynne McClure** is Director of Cambridge Mathematics. She has had a varied career in mathematics education, with experience ranging from head of a small primary school to senior university academic. A well-known conference speaker and professional development lead, she has authored or edited many books and articles. She worked with the Shell Centre on QCA's World Class Tests projects, was Director of the NRICH project and PI on the DfE-funded innovative A-level project Underground Maths.

On the policy front she chaired the teams which attempted to advise ministers on the content of the new National Curriculum and associated assessments. She was a member of the Advisory Committee on Mathematics Education from 2009 to 2013, President of the Mathematical Association in 2014/15 and is now Chair of the International Society for Design and Development in Education.



**Phil Daro** is an author of the Common Core State Standards in Mathematics, which are used by most states in the USA. He is a mathematics educator who works with teachers and school systems and has led large-scale curriculum and assessment programs. He continues to work to advance the design and use of leadership tools for improving mathematics instruction and assessment at every level of the educational system.

In 2012, he received the Walter Denham Award from the California Mathematics Council for his leadership, and in 2014, the Ross Taylor/Glenn Gilbert National Leadership Award from the National Council of Supervisors of Mathematics. He serves on the Executive Committee of the International Society for Design and Development in Education, the Board of the Strategic Education Research Partnership, the Board of Nottingham's Shell Centre Publications. He is a Member of the NAEP Validity Studies Panel.



# The Policy Advisers

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**David Laws** is Executive Chairman of the Education Policy Institute, which he joined in September 2015. The Institute is an independent, evidence-based research institute that aims to promote high quality education outcomes for young people.

Between 2010 and 2015, he served in the Coalition Government as Chief Secretary to the Treasury, Schools Minister, and Cabinet Office Minister. Whilst Schools Minister he was responsible for policy areas including: all capital and revenue funding, the Pupil Premium, accountability and policy on teachers and leadership.

An economist, David worked previously at J.P. Morgan and Barclays de Zoete Wedd before becoming Member of Parliament for Yeovil from 2001 until 2015.



**Alaster Smith** is the Head of Social Research in the Higher Education Analysis Division in the Department for Education. After a PhD on the behavioural consistency of terrorist groups at Liverpool University, he started his Government career in 1997 as a social researcher in the Home Office. There he worked on a range of issues such as patterns of vehicle theft, efficacy of organised crime legislation and police use of DNA and other forensic evidence. In 2008 he joined the Government Office for Science to lead a programme of departmental Science and Engineering Assurance reviews, looking at how government departments used evidence in their strategic decisions and policy making processes. In May 2014 he joined the Higher Education Directorate, moving to his current research role in 2016.



**Paul Black** is Professor Emeritus of Education at King's College London. He has made many contributions to research into learning and assessment. Nuffield A-level Physics transformed the teaching of Physics and, after more than 40 years, is still used in schools. His work on formative assessment with Dylan Wiliam and others has had widespread impact – not least, inspiring the Shell Centre-Berkeley Mathematics Assessment Project.

During the creation of the National Curriculum he worked closely with Government as Chair of the Task Group on Assessment and Testing. He has served on advisory groups of the USA National Research Council, and has received a lifetime service award from the US National Association for Research in Science Education.



**Neil Carmichael**, as Member of Parliament for Stroud, served on Education Select Committee from 2010-17, latterly as Chair. He established the All Party Parliamentary Group on School Leadership and Governance. He was also Chair of the Vascular Disease APPG, producing influential reports on clinical methods - reflecting his concern with professional practice in a research-based field.

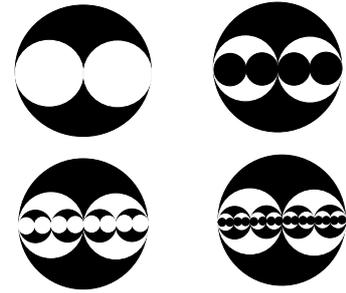
His writing on education include Building Better Boards: An Opportunity for Education, (2015), Sharing Resources, Securing Success – Making sure MATs and Education Groups Work (2017) and a book “Progressive, Productive, Proper: A new reform agenda for education” to be published in the Spring.



# Shell Centre designer-researchers



**Rita Crust** was lead designer of MARS US Balanced Assessment tests and the Shell Centre design work of for several MARS projects. She led the design of the paper-based tasks of the 8-11 materials for World Class Tests and Developing Problem Solving. She led the design of the paper-based components of the 5-14 Progress Tests in Mathematics and is designing modelling lessons for the Australian reSolve project.



The task in the graphic asks "What fraction of each area is black?"



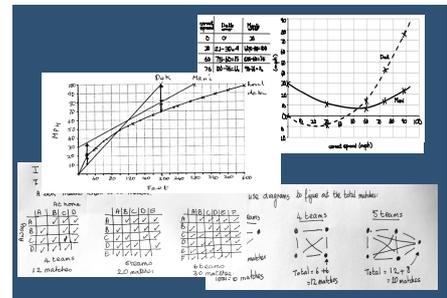
**Daniel Pead** has contributed to the design of computer-based learning and teaching materials in many Shell Centre Projects since the early 1980s, becoming IT director for the Shell Centre and MARS when Richard Phillips retired. He research work includes the strengths and limitations of computers in assessing complex student performances.



The graphic shows a visual database from the Bowland Maths module *Reducing Road Accidents*.



**Sheila Evans** has worked at the university since 2010 on several design research and intervention evaluation projects. An area of research she is particularly interested in is student talk. She is working towards a doctorate based on how students make sense of other students' work, and how this benefits their learning. The research includes designed student responses.



The graphic shows several designed responses for students to discuss.



**Clare Dawson** joined the Shell Centre team in 2010 to work on the Mathematics Assessment Project. She has since contributed to a number of Shell Centre projects, designing assessment tasks, classroom activities and professional development materials. Her interests lie in the dynamic, creative use of classroom resources, working collaboratively with teachers to impact and improve practice.

The graphic shows a card sort from the MAP module *Describing and Defining Triangles*.

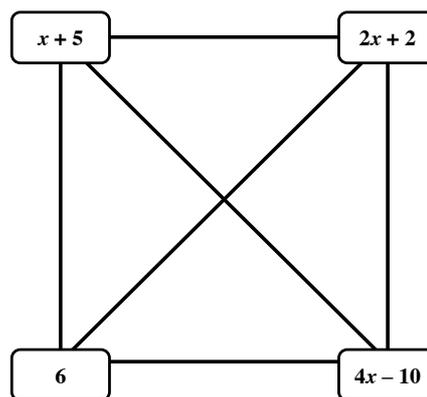
Card Set: Possible Triangles?

|   |   |
|---|---|
| A<br>AB = 3 cm,<br>BC = 7 cm,<br>AC = 4 cm.             | B<br>BC = 6 cm,<br>AC = 10 cm,<br>Angle B = 90°.        |
| C<br>Angle A = 50°,<br>Angle B = 50°,<br>Angle C = 80°. | D<br>Angle A = 40°,<br>Angle B = 60°,<br>AB = 5 cm.     |
| E<br>AC = 5 cm,<br>AB = 7 cm,<br>Angle B = 30°.         | F<br>BC = 7 cm,<br>AC = 4 cm,<br>Angle B = 45°.         |
| G<br>BC = 8 cm,<br>AC = 6 cm,<br>Angle C = 50°.         | H<br>Angle A = 60°,<br>Angle B = 60°,<br>Angle C = 60°. |
| I<br>AB = 6 cm,<br>BC = 6 cm,<br>AC = 6 cm.             | J<br>BC = 4 cm,<br>Angle B = 30°,<br>Angle C = 60°.     |



**Colin Foster** contributed to the design of the 100 formative assessment lessons in the Mathematics Assessment Project. He is particularly interested in how rich mathematical tasks can be used to develop students' fluency in important mathematical procedures – in more stimulating and powerful ways than is typical with routine exercises.

The graphic shows an example of such a *mathematical etude*, where the task is to solve the six equations formed by connecting every pair of expressions, notice what is special about the solutions, and construct another 'expression polygon' like this one.



**Diane Dalby** joined the research team in September 2014 after completing her doctorate in Mathematics Education at the University of Nottingham. She has worked on several design projects, including I Mathematics and Science for Life. (see graphic) Her previous experiences, ranging from teaching mathematics in schools to senior management in a large Further Education college, led to a keen interest in mathematics for post-16 vocational education.



... and finally, we want to acknowledge the massive contribution of

**Malcolm Swan**, who led the design team on many Shell Centre projects from the early 1980s until his death earlier this year. He was the first recipient, for *The Language of Functions and Graphs*, of the Prize for Excellence in Educational Design of ISDDE, the International Society for Design and Development in Education and, with Hugh Burkhardt, of ICMI's Emma Castelnuovo Prize for impact on the practice of mathematics education. The ICMI citation included:

*"Burkhardt and Swan have served as strategic and creative leaders of the [Nottingham-based Shell Centre](#) team of researcher-designers. That team has included many talented individuals over nearly 4 decades, in parallel with the contributions of more recent teams of international collaborators. Burkhardt and Swan are selected because of their continuous leadership of this work. Together, they have produced groundbreaking contributions that have had a remarkable influence on the practice of mathematics education as exemplified by Emma Castelnuovo."*



Which sport will produce a graph like this?

