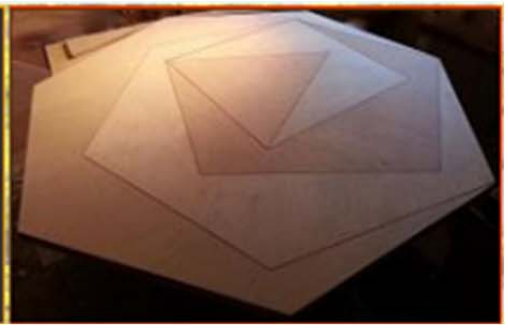
August 5-9, 2014
Workshop on Making Models:
Stimulating Research In Rigidity Theory And Spatial-Visual Reasoning
Held at the Fields Institute



For geometry teachers and educators of all ages!

As part of the Workshop on Making Models: Stimulating Research in Rigidity Theory and Spatial-Visual Reasoning, hosted by The Fields Institute for Research in Mathematical Sciences, Toronto, Ontario, we are pleased to invite you to a special two-day event on:

Spatial Visual Reasoning in the Classroom and in Educational Research
Friday August 8 and Saturday August 9, 2014

Supported by the Fields MathEd Forum, this meeting is open to K-12 teachers, university and college instructors, education researchers, and mathematicians.

Our overarching aim is to promote initiatives in spatial-visual approaches to mathematics thinking and learning. Workshop session leaders bring together expertise in mathematics, educational research, psychology, and spatial cognition to discuss how these ways of reasoning are important for mathematics learning and to explore ways of nurturing them in learners from early age to post-secondary education. Throughout the workshop there will be opportunities to make, use, and play with (physical, virtual, and dynamic) mathematical models.

A variety of sessions have been planned to support and foster educational initiatives in spatial-visual reasoning, including interactive discussion groups, model-making sessions, panel plenaries, as well as research talks by Nora Newcombe (Temple University) and David Henderson (Cornell University), among others.

To register, visit: http://www.fields.utoronto.ca/programs/scientific/14-15/making_models/

A schedule and program for the two days is included below. Click on the blue hyperlinks to view the session descriptions / abstracts and session leader information.

We look forward to seeing you there!

Schedule for Friday, August 8, 2014

9:00 – 10:30	**Plenary Panel:** ***Exploring the roles of the visual, spatial, and dynamic in mathematical thinking and learning*** Joan Moss (OISE); Donna Kotsopoulos (Wilfred Laurier University); Jerome Proulx (UQAM); Walter Whiteley (York University)
10:30 – 11:00	*Coffee Break – light refreshments provided*
11:00 – 12:00	***Thinking about quantity: The intertwined development of spatial and numerical cognition*** Nora Newcombe (Temple University)
12:00 – 1:30	*Lunch* (on your own)
1:30 – 2:30	***Discussion Groups / Model-Making Sessions***
2:30 – 3:30	***Poster Session***
3:30 – 4:00	*Coffee Break – light refreshments provided*
4:00 – 5:00	***Experiencing geometry in elementary and high school*** David Henderson (Cornell University)

Schedule for Saturday, August 9, 2014

9:00 – 10:00	***Discussion Groups / Model-Making Sessions***
10:00 – 10:30	*Coffee Break – light refreshments provided*
10:30 – 11:10	***Early spatial understanding: What do we know about it and why does it matter?*** Yukari Okamoto (University of California Santa Barbara), Lisa Weckbacher (California State University), David Hallowell (University of California Santa Barbara)
11:10 – 11:50	***Teaching, learning, and modeling with geometry in the middle and high school classrooms*** Carl Lee (University of Kentucky)
11:50 – 12:30	***Developing spatial-visual reasoning in classrooms and the CUPM geometry study group report*** Sarah Greenwald (Appalachian State University)
12:30 – 1:30	*Lunch* (provided by the Fields MathEd Forum)
1:30 – 2:30	***Discussion Groups / Model-Making Sessions***
2:30 – 3:00	***Closing Session***

Thinking about quantity: The intertwined development of spatial and numerical cognition

Nora Newcombe (Temple University)

Abstract: There are many continuous dimensions that collectively define the physical world. Philosophical, psychological and neural work has focused especially on space and number. However, there are other important continuous dimensions (e.g., time, mass) and space can be broken down into more specific dimensions (e.g., perimeter, area). Number is a distinctive continuous dimension, in that "count words" and early teaching of arithmetic emphasize discrete numerical quantity, rather than continuous quantity. I will argue that a generalized magnitude system is the starting point for the development of both spatial and mathematical thinking, and that development consists of (1) increasing flexibility, accuracy and capacity in magnitude estimation, (2) differentiation of the generalized magnitude system into separable dimensions, (3) discretization of numerical quantity and subsequent remapping of the discrete numbers onto a continuous number line. These conclusions have implications for mathematics education.

Bio: Nora S. Newcombe is Professor of Psychology and James H. Glackin Distinguished Faculty Fellow at Temple University. Her Ph.D. is from Harvard University. Her research focuses on spatial cognition and development, as well as the development of autobiographical and episodic memory. She is currently Principal Investigator of the NSF-funded Spatial Intelligence and Learning Center (SILC) and co-directs the Temple Infant and Child Laboratory (TICL) on Temple's Ambler Campus and the Research in Spatial Cognition (RISC) Lab on Main Campus. Dr. Newcombe is the author of numerous chapters, articles, and books, including Making Space with Janellen Huttenlocher (published by the MIT Press, 2000). Her work has been recognized by several awards, including the William James Award, the George A. Miller Award and the G. Stanley Hall Award. She is a member of the American Academy of Arts and Sciences and of the Society of Experimental Psychologists. She has served as Editor of the Journal of Experimental Psychology: General and Associate Editor of Psychological Bulletin, as well as on many grant panels and advisory boards.

Experiencing geometry in elementary and high school

David Henderson (Cornell University)

Abstract: I will demonstrate some of my on-going work with K-12 teachers and students to develop experiential geometric activities/curricula based on the ideas from my college-level text Experiencing Geometry.

Bio: David Henderson is retired from the Department of Mathematics, Cornell University, after 47 years. He has written several books including (with Daina Taimina) Experiencing Geometry: Euclidean and Non-Euclidean with History. Currently, he is involved in two national geometry curriculum projects: one at the high school level with the Algebra Project and the other an elementary school project (with Rich Lehrer) supported by the NSF.

The importance of early exposure to spatial activities in promoting strong spatial sense and success in science, technology, engineering, and mathematics (STEM) disciplines

Yukari Okamoto (University of California Santa Barbara), Lisa Weckbacher (California State University), David Hallowell (University of California Santa Barbara)

Abstract: Spatial reasoning is essential to success in STEM disciplines. However, little attention is given to spatial reasoning in current school curricula. In mathematics, for example, numerical solutions are typically emphasized at the expense of spatial solutions. There is an urgent need to foster students' spatial reasoning skills. In this presentation, we first synthesize recent findings supporting the link between spatial reasoning and performance in STEM disciplines. This includes findings from our lab that highly spatial high school students outperformed their low spatial peers in geometry. We next synthesize the literature on young learners' understanding of geometry and the importance of early exposure to spatial activities. This includes findings from our lab that first graders showed difficulty identifying features of geometric shapes and that highly spatial middle-school students had been exposed to spatial activities from early years. Implications for educational practices will be discussed.

Bio: Yukari Okamoto is a Professor in the Department of Education at the University of California Santa Barbara. She specializes in children's cognitive development. She is particularly interested in young children's mathematical, scientific, and spatial thinking. Her current projects include: (1) the development of whole number and rational number knowledge, (2) preschool children's biological reasoning, and (3) young children's geometric and spatial thinking. She received a Ph.D. from Stanford University, and was a Spencer Dissertation-Year Fellow for Research Related to Education. She was also a Spencer Foundation Postdoctoral Fellow.

Teaching, learning, and modeling with geometry in the middle and high school classrooms

Carl Lee (University of Kentucky)

Abstract: We will offer some insights gained from two geometry projects. In the first, supported by the National Science Foundation, we developed written instruments to measure high school teachers' knowledge for teaching volume, surface area, congruence, and similarity, and a classroom observation tool to measure the level of sophistication of teaching moves and strategies during class. We will report on some early results on correlations between data gathered with these instruments and student performance. In the second project we will discuss our experiences with working with seventh and eighth graders as they became acquainted with the software *SketchUp* and began modeling with it.

Bio: Carl Lee grew up in an extended family of academics. One of his earliest memories of his love of mathematics was in second grade when his mother taught him how to multiply with a slide rule. As he grew older he devoured his father's recreational math books, encountering flexagons, polyhedra, stitchings of conic sections, and many more lifelong friends. Gardner, Steinhaus, Ball and Coxeter, and Cundy and Rollett were his silent mentors who complemented his wonderful public school teachers in Baltimore County. He couldn't find the polyhedra in college (Yale), but learned where they were lurking in graduate school (Cornell, 1981, Applied Mathematics), and now he surrounds himself

(sometimes physically) with higher dimensional ones. He was welcomed by the Department of Mathematics at the University of Kentucky in 1980, where he has found a supportive environment for his interests in discovering, teaching, learning, and playing with mathematics. He was an IBM Postdoctoral Research Fellow, an Alexander von Humboldt Fellow, a recipient of a Provost's Outstanding Teaching Award, an MAA Deborah and Franklin Tepper Haimo Teaching Award winner, and is presently a Chellgren endowed Professor, continuing investigations into polyhedral and discrete geometry, while engaged in mathematics education and outreach projects.

Developing spatial-visual reasoning in classrooms and the CUPM geometry study group report

Sarah Greenwald (Appalachian State University)

Abstract: The Geometry Study Group was charged by the Mathematical Association of America Committee on the Undergraduate Program in Mathematics (CUPM) Steering Committee to make recommendations about geometry in the undergraduate mathematics curriculum. I'll summarize our peer-reviewed report (http://cs.appstate.edu/~sjg/geom/CUPM-Geometry-Rpt.pdf), which represents our considered opinions, based on consultation with the larger community through surveys, interviews and the literature. I'll also share some of my own experiences in developing spatial-visual reasoning in my classrooms, giving examples from general education mathematics, linear algebra and geometry courses.

Bio: Sarah J. Greenwald is Professor of Mathematics and a Women's Studies core faculty member at Appalachian State University. She received her PhD from the University of Pennsylvania, specializing in the Riemannian geometry of orbifolds. She is the associate editor of the Association for Women in Mathematics Newsletter and she co-edited the 3-volume Encyclopedia of Mathematics & Society with Jill Thomley, which was named a "Best Reference 2011" by Library Journal. She co-created the educational website SimpsonsMath.com with Andrew Nestler and has a number of teaching awards, such as the College of Arts and Sciences Outstanding Teacher of the Year. She has co-organized a number of visualization sessions at past Joint Mathematics Meetings, led an honor's thesis on visualization and is a member of the CUPM 2015 Geometry Study Group.

Discussion Groups / Model-Making Sessions

These sessions are designed to be interactive and collaborative opportunities to build on the emergent themes and issues from the workshop. Each session will include three 1-hour meeting times where participants will be invited to engage in focused discussions and model-making initiatives that could lead to new research arenas or teaching initiatives. The role of the discussion group leader is to spark, direct, and facilitate these collaborations through a mix of discussion topics/questions, interactive activities, and presentation. We request that participants select one of the discussion group / model-making sessions for all three hours. Sessions leaders have designed their sessions to be accessible and relevant to all workshop participants including practicing teachers, teacher educators, researchers, and mathematicians.

Connecting algebra and geometry through model-making

Benjamin Braun (University of Kentucky)

Description: The interaction of algebraic and geometric ideas has always been a driving force in mathematics teaching, learning, and research. In this working group, we will investigate and articulate strands of interaction between algebra and geometry that extend vertically throughout the mathematics curriculum. The hope is that we will be able to identify coherent themes that begin in early childhood education and extend to graduate-level studies. A major goal for this group will be to identify ways that model-making enhances the teaching and learning of these curricular strands, and to describe sequences of models that accompany them.

Bio: Benjamin Braun received his B.A. in Mathematics and English at Truman State University and his Ph.D. in Mathematics at Washington University in Saint Louis. He has been a faculty member at the University of Kentucky since 2007. His mathematical research is in algebraic and geometric combinatorics; if there is a polytope or simplicial complex involved, he's interested. His scholarly interests in teaching and learning include using writing in mathematics courses, preservice teacher education, pedagogical use of the history of mathematics, and connections between mathematics education and cognitive/social/educational psychology.

Making models with 3D software

Kate Mackrell (University of London)

Description: In a technology environment, objects do not need to be constrained by opacity, solidity, or gravity. This opens a wealth of possibilities for making dynamic models that are both aesthetically pleasing and mathematically intriguing. In this session we will use Cabri 3D to make a variety of such models, including popcorn boxes, fold-up Archimedean solids, and symmetrical collections of flexible rhombic polyhedra. Demo software will be provided. Participants are asked to bring their own laptops for this session.

Bio: Kate Mackrell is a PhD candidate in mathematics education at the Institute of Education, University of London, specializing in task design with dynamic geometry software. Kate has worked in computing, secondary schools, and in teacher education at the University of Brighton in the UK. She is currently involved in designing activities with technology for a number of diverse curriculum projects.

Ad Hoc Sessions – Emergent Research Conversations

Over the course of the workshop various discussions and ideas may emerge. Our program is designed with time and space for participants to come together and work on their emergent ideas. In order to facilitate *Ad Hoc research-oriented discussions,* there will be a notice board available to request and announce the sessions. The nature of the spaces for ad hoc sessions will reflect the discussion format, and there will be a limited number of spaces available. Ad hoc proposers should not expect access to a classroom, computer, projector or power, and sessions proposed should be designed with this in mind.

Poster Presentations

Melanie Langemeyer, Donna Kotsopoulos, & Michelle Cordy (Wilfred Laurier University)	*Efficiency of representational thinking amongst high achieving children in a large-scale mapping task*
Asia Mathews (Queen's University)	*Extending mathematical relationships to new, related problems through visualization: How can we guide students to do this on their own?*
Jérôme Proulx (Université du Québec à Montréal)	*Mental mathematics and spatial reasoning: strategies and problem posing*
Nenad Radakovic (OISE)	*Using dynamic visualizations to develop secondary school students' Bayesian reasoning*
Robyn-Ruttenberg-Rozen (York University)	*Mathematical learning disabilities and visual-spatial reasoning: What does the research say?*
Diane Tepylo (OISE), Joan Moss (OISE), Cathy Bruce (Trent)	*Changing geometry teaching in primary classrooms: Incorporating spatial reasoning clinical interviews with lesson study*
Martha Younger (OISE)	*Adding spatial skills activities to the middle school mathematics teachers' toolkit: the impact of spatial skill activities on mathematical thinking*