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Preface

Welcome to the 22nd annual Bridges Conference! This year we travel to Linz, the beautiful capital of the state of Upper Austria, on the banks of the Danube River. In the city where Johannes Kepler discovered his third law of planetary motion, mathematicians, scientists, artists, musicians, architects, dancers, designers, writers, educators, and other explorers of the deep connections between mathematics and the arts come together in a lively atmosphere of intellectual exchange. Our host institutions this year are Johannes Kepler University and Ars Electronica Centre.

Johannes Kepler University (JKU), the largest university in the region of Upper Austria, will host Bridges 2019 in its STEM Education Centre. Here, Professors Markus Hohenwarter and Zsolt Lavicza have established a STEM Education Research Group which is integrating the arts to become a STEAM education center in the near future. The STEM Education Research Group runs a Masters and PhD program in mathematics, science and computer science education. Currently, there are 12 PhD students and 20 masters students enrolled in its program. The group also works in close connection with more than 160 international GeoGebra Institutes, a network of teacher education and research groups at universities in 75 countries that has its headquarters in Linz. The STEM Education Research Group holds regular seminars, organizes conferences, and hosts international visitors, all to create and support an environment for international research. The mathematics education team has many years of experience in research and development projects and a profound knowledge of all aspects of teaching and education.

The Ars Electronica Festival began in Linz in 1979, bringing together artists and scientists from around the world every two years for an interdisciplinary exploration of a particular theme. In 1986, the festival became an annual event, and ten years later, the original Ars Electronica Center opened. When Linz was designated a European Capital of Culture in 2009, the center was expanded into the vibrant facility we see today. The Ars Electronica Center is a museum of the future, devoted to the themes of Art, Technology, and Society. In addition to the annual festival, the center runs the Prix Ars Electronica competition and the Futurelab research and development facility. The exhibitions in the Ars Electronica Center are built around interactivity and participation, allowing visitors to immerse themselves into visions of future society and explore how we communicate with our environment. Here, biotechnology, genetic engineering, neurology, robotics, prosthetics, virtual reality, media art, and all of their intersections are on display, and there are no “Do Not Touch” signs. The integration of art and science, the focus on innovation and education, and the emphasis on interactivity are all themes that resonate with the mission of the Bridges Organization, and we are grateful that Ars Electronica is joining JKU in opening their doors to our community.

This year’s Bridges Program Chair is Susan Goldstine. She coordinated an international Program Committee of over 75 experts who provided extensive reviews and editorial comments on the roughly 200 submissions we received this year. She also served as chair of the regular paper track, and as chair of the Math + Fashion Show committee. Douglas McKenna chaired the short
paper track, and Kristóf Fenyvesi chaired the workshop paper track, each handling a record number of submissions. David Chappell designed the Kepler-inspired planetary orbit cover for the proceedings and the complementary cover for the art catalog. Special thanks go to Bianca Violet for heading the Short Film Festival committee, to Sarah Glaz and Emily Grosholz for organizing the Poetry Reading, to Uyen Nyugen for proposing and editing the Math + Fashion Lookbook, to Stephen Abbott for running the Theater Event, to Mike Naylor for leading Informal Music Night, and to Kristóf Fenyvesi for organizing the public Family Day.

The 2019 edition of the Bridges proceedings includes 4 invited papers, 41 regular papers, 59 short papers, and 17 workshop papers. Among these pages, you will find new discussions of the aesthetics of mechanical puzzles, freeform surfaces in architecture, fractals and generative art, paper folding, polyhedral models, fiber arts, poetry construction, mathematical music, large-scale crop designs, art in the mathematics classroom, and many other topics. We have workshops on music, perspective hand-drawing, mathematical connections in dance and body movement, creative methods in STEAM and technology for education, paper folding, creative writing, creating digital art, and hands-on geometric constructions. It is a testament to the vibrancy of the Bridges community that we have so many excellent papers on such a wide variety of topics. We are especially grateful to this year’s Program Committee for their core service in the increasingly difficult task of selecting papers from our ever-growing pool of submissions, and for helping our authors to make their work shine. Extra thanks to Eve Torrence, George Hart, and Craig Kaplan for their advice and support throughout the process.

An exhibition of mathematical art has been an annual feature of Bridges since 2001. Artists participate from around the world, representing diverse cultural backgrounds. A wide variety of artistic media are represented in the exhibition, including 2D and 3D digital prints, drawing, painting, beadwork, weaving, ceramics, woodwork, stained glass, metalwork, quilting, and paper cutting and folding. Artists drew inspiration from the mathematics of fractals, polyhedra, non-Euclidean and four-dimensional geometry, tiling, knot theory, number theory, and more. This year Uyen Nguyen and Robert Fathauer served as co-curators of the exhibition. The jury considering the artworks consisted of Karl Kattchee, Barbara Lichtenegger, Uyen Nguyen, and Robert Fathauer. The print catalog was prepared by Conan Chadbourne with cover art by David Chappell, and the art submission website was created and administered by Nathan Selikoff. Barbara Lichtenegger was the local art exhibition coordinator in Linz.

We are grateful for the contributions to the organization of the Bridges 2019 conference from Johannes Kepler University and Ars Electronica Centre in Linz. First of all, we would like to thank the local organizing committee Zsolt Lavicza and Sandra Reichenberger from JKU, Barbara Lichtenegger from the Private University of Education, Diocese of Linz, and Andreas Bauer from Ars Electronica Centre for their efforts in the organization and making this event happen. We are also thankful for the continuous support of Professor Markus Hohenwarter, the Head of the Linz School of Education, in making connections within the University and in the City as well as in securing substantial administrative and financial support for this event. JKU has greatly supported our efforts by offering the University facilities for the conference and
assisting us with technical and administrative issues; we are particularly grateful to Rektor Meinhard Lukas, who made the conference possible at JKU and granted financial support for the event. Also, we are thankful for the contributions of the PR office at JKU for helping with the design of our conference cards, posters and video. The promotional video was professionally produced by Chris Noelle and was viewed by thousands of interested people around the world. For administrative support in dealing with financial and booking arrangements, Barbara Fröhlich and Günter Sageder were incredibly helpful in making the conference run smoothly. We also appreciate the assistance and flexibility of the staff of the Sommerhaus Hotel. Similarly to JKU, the Ars Electronica Centre with the lead of Andreas Bauer offered incredible help in the organization and offered us their support and facilities for the conference. The Arts University in Linz was an active member of the organization and we appreciate that we can host events in its buildings. We are grateful to the Tabakfabrik for hosting us, and to Andreas Weixler and Se-Lien Chuang from Bruckner University for offering their facilities and expertise. Furthermore, the city of Linz and Upper Austria as well as the Linz City Tourist Office offered great help for supporting participants and organizing excursions. In addition, we are thankful for our student helpers and the long list of volunteers who signed up to assist at the Bridges conference. Finally, we would like to acknowledge the continuous assistance of Kristóf Fenyvesi as a liaison, both online and in person in his visits to Linz.

This year we were able to offer student travel scholarships to seven students from around the world who authored accepted papers and created mathematical artworks. We are very grateful to the Bridges community for supporting the Reza Sarhangi Memorial Fund through the rezafund.org online art auction to make this program possible. This is a testament to the enduring, generous spirit of Bridges founder Reza Sarhangi. We still feel his absence, but we take comfort in the strong and nurturing community he built.

We welcome you to join us in our celebration of mathematics and the arts, whether in person in Linz, through the pages of our printed publications, or in our online archive that covers two decades of magnificent work from conferences past. Bridges serves as a beacon for all those fascinated by the connections between mathematics and the arts. With your support, it will continue to light the way for many years to come.

The Bridges Organization Board of Directors and Bridges 2019 Chairs
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