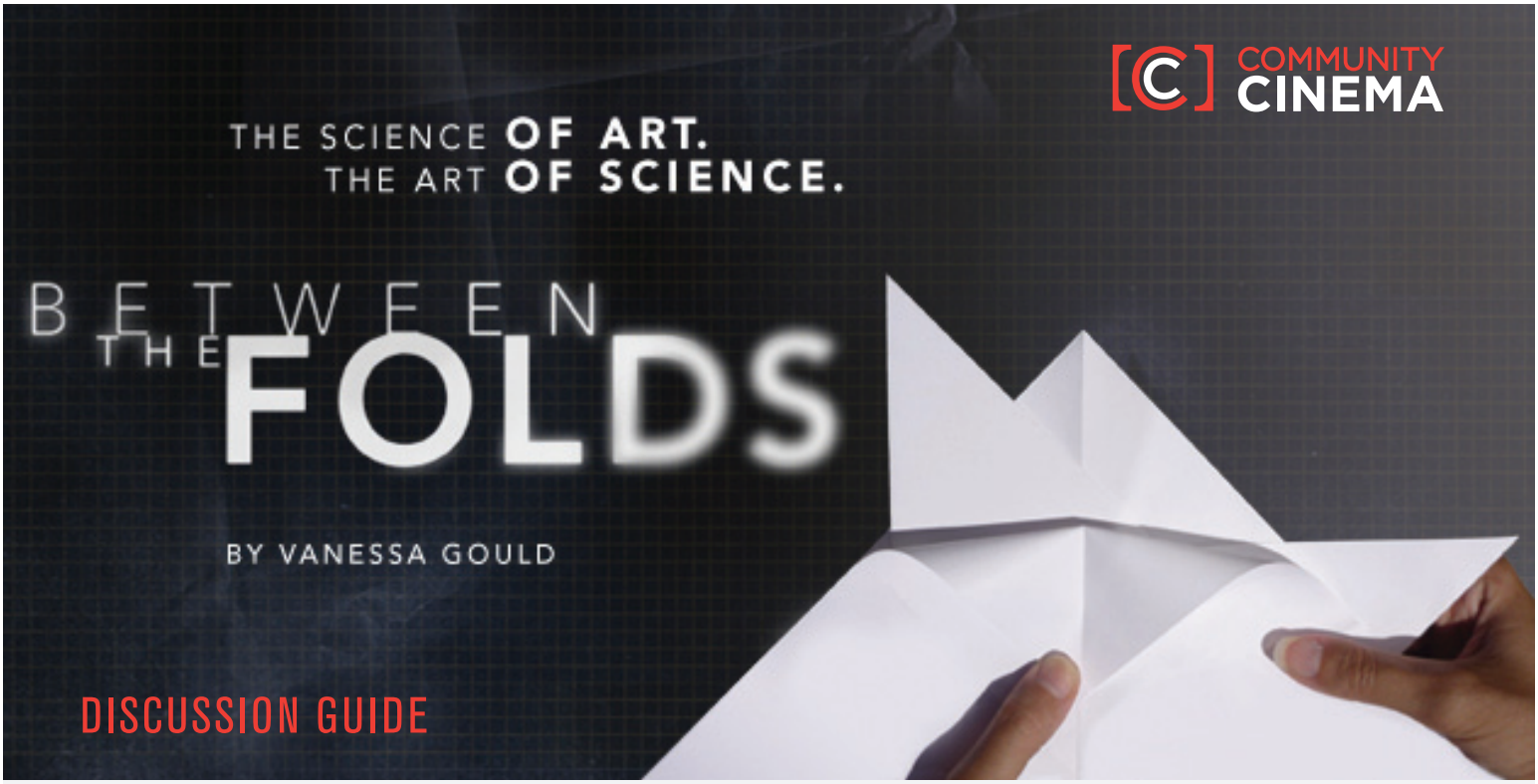


Think origami is just paper planes and cranes? Meet a determined group of theoretical scientists and fine artists who have abandoned careers and scoffed at hard-earned graduate degrees to forge new lives as modern-day paper folders. Together they reinterpret the world in paper, creating a wild mix of sensibilities towards art, science, creativity and meaning.

FROM THE FILMMAKER

At its heart, BETWEEN THE FOLDS is a film about potential. The potential of an uncut paper square. The potential of a wild scientific idea. The potential to see things differently.

For as long as I can remember, the driving impulses behind art, science, sculpture and math have felt deeply connected–all ways of interpreting our experiences in a language that's universal. When I first learned about the curious phenomenon of fine artists, scientists and mathematicians from all over the world working in the very same medium of origami, I knew there had to be something special about it–that in the simplicity of a paper square some untold potential for new connections and ideas must be hiding.

Curiously, the process of making this documentary became less about telling a story, and rather about finding an idea, or layers of ideas. Everyone involved in this project has been incredibly energized by the challenge of making a documentary film about ideas–their evolution, their beauty, their paradoxes and their mystery. We knew the project's central themes would speak to different people in different ways, as any film about ideas should. Therefore, it was of great importance that its themes be presented subtly and flexibly, so that every viewer can experience the film in ways that are both universally resonant and personally meaningful.

For me, as a filmmaker, this has also been a project about transformation–not only of paper squares, but of people and lives also. Most of those featured in the film left traditional lives to devote themselves to the thing they love most: paperfolding, the magical process of transforming two dimensions into three dimensions. Their remarkable stories resonated so strongly with me upon abandoning my own former work, that I was determined to bring their inspiring stories of transformation to light. And so, my devotion to this film rests in the hope that others take inspiration from these incredible stories, as well.

- Vanessa Gould

THE FILM

BETWEEN THE FOLDS takes a look at the art of paperfolding (also known as origami) and its practitioners around the world. Using descriptive titles as an organizing device, the film presents a fascinating array of artistic styles and introduces the little-known applications of this metamorphic art for solving real-world problems.

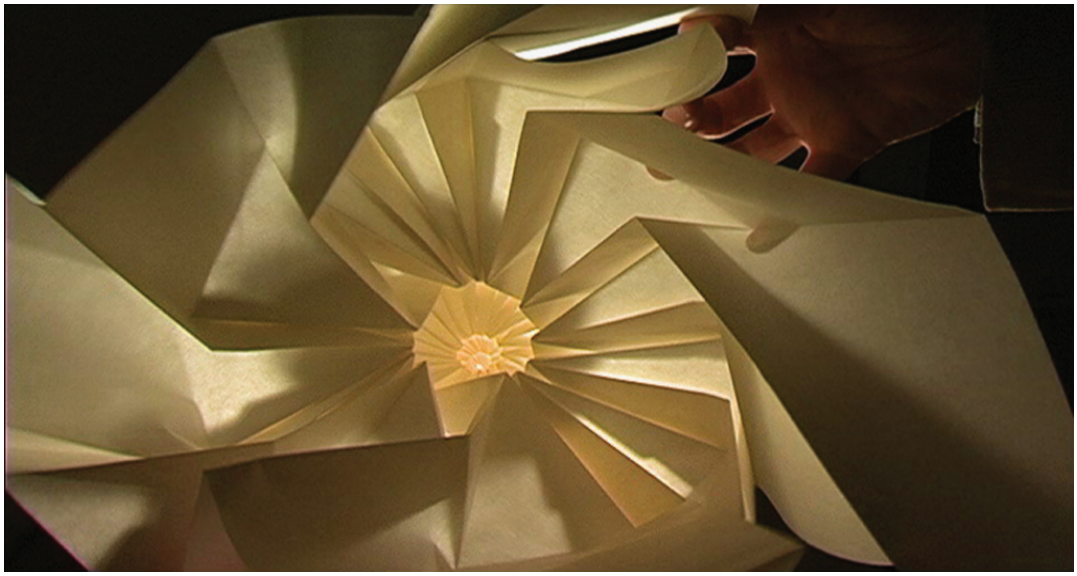
As it moves from artist to artist, the film explores the creative process that results in beautiful and unique objects. The medium itself is the first stop in this exploration, as Michael LaFosse (The Artisan) shows his papermaking process and discusses the properties of different types of paper. Eric Joisel (The Artist) takes a slow, deliberative approach to paperfolding, improvising as he goes along and never making the same object twice. Mathematical and geometric ideas form the basis of the complex patterns Robert J. Lang (The Engineer), a Caltech trained physicist, uses in his origami. All three of these artists point to Akira Yoshizawa (The Father) as the major influence on their work. Considered the creator of modern origami, Yoshizawa introduced many new techniques and raised origami from a humble craft to a sophisticated art form.

For Paul Jackson, (The Postmodernist), process is the whole point. The abstract objects he produces and their simple beauty are a result of his playing with the paper rather than the realization of a pre-conceived plan. Chris Palmer (The Choreographer) uses visual and mathematical patterns that change with movement and light, while the avant-garde Vincent Floderer and his collaborators in France (Les Anarchistes) experiment with a less orderly technique called crumpling.

Throughout the survey of the various artists, a discussion takes place about general issues underlying all forms of artistic expression—process versus product, technique versus emotional expression and simplicity versus complexity. The artists weigh in on these issues and the bearing they have on their work, leaving it up to the viewer to draw any conclusions.

Besides the artistic importance of origami, the film also reveals origami's connections to the world beyond art—to math, to science, to engineering—and its use as an educational and research tool in those fields. In Israel, Miri Golan has introduced an origami math program that is used throughout the country. Tom Hull, a college math professor in Massachusetts, uses origami models to illustrate complex math concepts. And at MIT, the father and son team of Erik and Martin Demaine are using computer algorithms to solve long-standing questions about the mathematical underpinnings of paperfolding, with Erik putting his theoretical skills to work on the problem of protein folding and the implications for designing custom drugs.

All of these paperfolders, artists and scientists alike, whether producing beautiful objects or finding new ways to fold airbags or space telescopes, are involved in a creative effort. Whatever their motivation or purpose, all start with a flat piece of paper—by just folding, they are able to interpret the world around them in unique and wondrous ways.



INDIVIDUALS FEATURED IN BETWEEN THE FOLDS

Michael LaFosse (USA) is the only paperfolding artist in the world who makes the medium (paper) itself.
Eric Joisel (France) makes people and animals, in a caricature-like style.
Robert J. Lang (USA) is a former physicist who uses mathematical ideas to create shapes.
Akira Yoshikawa (Japan) is the "father" of modern origami; he devised a system of directions for folding that appears in all origami books today.
Paul Jackson (Israel) is a postmodern paperfolding artist who emphasizes the importance of process.
Chris Palmer (USA) creates patterns influenced by designs found in the Alhambra.
Vincent Floderer (France) is an avant-garde folder who uses a style called crumpling in his creations.
Miri Golan (Israel) devised an origami math program to make geometry visual.
Tom Hull (USA) is a math teacher in Massachusetts who uses advanced origami in the classroom.
Erik Demaine (USA) is an MIT professor and top origami theorist in the world.
Martin Demaine (USA) is Erik's father, as well as a sculptor, computer scientist and puzzle maker.
Bernie Peyton (USA) is a bear biologist and paperfolder.
Brian Chan (USA) is an MIT student and folder of "Mens et Manus."
Satoshi Kamiya (Japan) is a young Japanese prodigy and folder of "Eastern Dragon."

BACKGROUND INFORMATION

History

The origins of origami are not clear, but it is thought that techniques of papermaking were brought to Japan from China in the early seventh century. The Chinese also developed paperfolding techniques that were later introduced into Japan. At first, paperfolding was used for practical purposes, such as folding letters. The beginning of the Edo period (1600-1668) saw the development of cheap and mass-produced paper; the availability of this material made it possible for paperfolding to become an art form. After the first books about origami were published in the late 1790s, the art of paperfolding was given a formal name. Origami comes from the Japanese words oru (to fold) and kami (paper).

Akira Yoshizawa is considered the grand master of origami, the man who raised it from a quaint craft to a creative art form. Born near Tokyo in 1911, Yoshizawa became interested in origami as a child. As a young man, he used origami to teach geometry to apprentice draftsmen in a tool factory, a job he left in 1937 to pursue origami full time. For the next fifteen years, he lived in poverty until he was hired in 1951 to design a set of origami zodiac symbols to illustrate a Japanese magazine article. When the article was published, he became an overnight sensation and more commissions came his way. He founded the International Centre for Origami in Tokyo, and his work was exhibited in the United States and Europe—including part of a major international exhibition at the Louvre in 1998.

When he was younger, Yoshizawa studied Buddhism, with plans to become a priest. Although he never entered the monastery, he remained a devout man and would often pray before beginning a folding session. Yoshizawa pioneered many origami techniques—one in particular being the technique of wet folding, which involves spraying water onto a thick piece of paper that can then be molded into a three-dimensional shape. He also developed a notation system to show the fold lines for making specific objects and the directions of the folds—a system used in most origami books today.

Beyond Art: Relationship to Math, Science & Engineering

Paperfolding is not just a form of artistic expression; it also has practical applications in science, technology and other areas of everyday life.

In September 2006, the Fourth International Conference on Origami in Science, Mathematics, and Education (4OSME) was held at the California Institute of Technology in Pasadena, California. Every few years, this interdisciplinary conference brings together artists, scientists, technologists and educators who explore the relationships between their disciplines. In 1989, 1994 and 2001, the first three meetings devoted to origami research and applications in mathematics, science and education were held in Italy, Japan and California, respectively. The fifth OSME meeting will take place in Singapore in August 2010.

Mathematics

Origami has very broad applications in the field of mathematics. It can be used to teach ratios, fractions, and percents; angles; area and volume; congruence; symmetry; tessellations; properties of parallel lines; products and factors; conic sections; Euler's formula (applied to algebraic topology); geometry; and concepts from calculus, such as tangent line approximations to curves or negative curvature in a hyperbolic paraboloid. Mathematicians are interested in investigating a wide range of questions relating to paper folding. Some of these questions relate to the design, classification or colorings for origami representations of mathematical objects, such as polyhedra or tessellations. Others are focused on understanding what the crease patterns from different figures have in common when unfolded. Some mathematicians design computer algorithms that solve mathematical origami questions.

Science, Engineering and Other Practical Applications

Here are some examples of how origami has been used in science and engineering and how it might be used in the future:

Solar sails

In March of 1995, Japanese scientists used origami concepts to pack and deploy a solar power array in a research vessel launched by the Japan Aerospace Exploration Agency (JAXA). Folded into a compact parallelogram, the solar array expanded into a solar sail in space.

Digital camera lens

In January 2007, Eric Tremblay and Joseph Ford, from the University of California in San Diego, made an ultrathin, high-resolution origami lens, seven times more powerful than conventional camera lenses. All of the reflective surfaces are cut out of a single component. Instead of bending and focusing light as it passes through a series of separate

mirrors and lenses, the new "folded" system bends and focuses light while it is reflected back and forth inside a single five millimeter thick optical crystal. In other words, the lens itself is not folded, but the optical path is folded.

Space telescope
An Eyeglass is a foldable telescopic lens, designed to be 100 meters in diameter, or about the size of a football field. A project of the Lawrence Livermore National Laboratory in California, the telescope is still years away from being built, but work has begun on developing ways to fold the lens so that it can fit into the payload space of currently available space vehicles. Professional origami artist Robert J. Lang has helped scientists design a method for folding a space telescope, and several prototypes have been constructed to test the design.

Stents
In 2003, at the University of Oxford, Zhong You and Kaori Kuribayashi developed an origami stent to be used for enlarging clogged arteries and veins. A pattern of origami folds was used to design the stent, making it geometrically simple so that it could be made of any biocompatible material at a relatively low cost.

Air bags
Origami artist Robert J. Lang worked with a German company, EASi Engineering (now carhs GmbH), to help design an algorithm to allow computer simulations of airbag folding and deployment. Using an algorithm also allows the company to evaluate the efficiency of the airbags without actually doing a crash test.

Map folding
The Miura-ori (Miura-fold) is a method of map folding that allows a square piece of paper to be folded in such a way that it can be opened in one motion by pulling at two opposite corners. The design makes the map just as easy to refold, and less likely to tear. It is called Miura-ori, in honor of Koryo Miura, a professor at Tokyo University, who developed the fold– the same method of folding that was used on the solar sails described previously.

Try a Miura Map Fold here: http://mars.wnec.edu/~thull/combgeom05/handout7.pdf

Source: www.origami-resource-center.com/origami-science.html

DNA origami – nanoscale creations
Based on the molecular binding properties of DNA, scientists in Denmark have identified the specific molecules of DNA that fold themselves into a box. They believe this structure could function as a nanoscale "medicine cabinet," carrying drug molecules through the blood stream and delivering them to a particular target in the body. U.S. and German scientists have also found ways to control the shapes that DNA folds itself into, making it possible to engineer tools on a nanoscale level. Although putting these findings to practical use is still many years away, there is potential in the fields of electronics, medicine, molecular biology and therapeutics.

Protein folding
Proteins are the basic unit of life, carrying the messages contained in the DNA of our genes. Proteins are made up of amino acid sequences, and in order to do their messenger work—that is, determine the color of our hair or eyes and other characteristics of our bodies—the amino acid sequences fold up into a three-dimensional structure. When these proteins misfold, the result can be diseases such as Alzheimer's, cystic fibrosis, mad cow disease and other physical problems. Scientists have been studying protein folding in order to learn how to simulate it and to create remedies (drugs and gene therapy) for situations when the folding process goes awry. The main challenge to this work is the speed with which proteins fold—some as fast as a millionth of a second—which computers are not yet able to simulate in real time. Scientists, such as Erik Demaine at MIT, are applying their skills to this problem in computational biology. It's possible that some day the mathematical algorithms derived from origami may help us find the answers.

THINKING MORE DEEPLY

1. What are your initial thoughts and feelings after seeing the various creations of the paperfolding artists in the film?

2. What are some of the common characteristics you noticed among the artists in the film?

3. The French artist Eric Joisel expresses concern about the level of complexity that some artists try to attain, by focusing on technique instead of the emotional aspect of their work. Robert J. Lang, however, points out that pure technique can become incorporated into works of art, as was the case with Chopin's musical etudes. Which of these men makes the stronger case—Joisel or Lang? What is the value of developing and practicing artistic techniques for their own sake?

4. Consider the onscreen quote by Henri Matisse at the beginning of the film: "Much of the beauty that arises in art comes from the struggle an artist wages with his limited medium." What struggles have artists in the film had with paper?

5. In considering the possibilities of what can be done with just one fold, Paul Jackson, the paperfolding artist living in Israel, talks about creative limits and how they can be freeing. How can that be? Wouldn't creative limits constrain an artist?

6. In describing their attraction to or work in origami, many of the artists in the film use the words 'fun,' 'crazy,' 'play' and 'magic.' Why do you think these words recur in their discussions of their relationship to the art of paperfolding?

7. Has seeing this film changed your perception of artists? Of scientists? Of mathemeticians? If so, in what way(s)?

8. What do you think the film's title refers to?

9. Do you agree with the film's narrator that artists and scientists are not that different? If so, how are they alike?

10. Do you think seeing and hearing about the process of creation as described in the film will change the way you look at other types of art works? In what way?

11. In what ways does the idea of transformation have a role in the film? In addition to the paper itself, what else transforms or changes over time?

SUGGESTIONS FOR ACTION

1. Invite a local paperfolding artist to offer a tutorial or workshop in basic folding techniques to people in your community. Create a community website where photos of the resulting creations can be posted, along with the creators' reflections (optional) on the process of paperfolding.

2. Though it is not exactly origami, many people enjoy making paper airplanes. Organize an intergenerational paper airplane design and demonstration activity, either as part of a larger community event or as a stand-alone activity. Encourage creativity and open-ended designs, but have designs and instructions available for those who would like to follow them. A good resource is www.paperairplanes.co.uk/planes.php. Ask a physics teacher or aeronautics expert to be on hand to explain the aerodynamics involved in the various types of planes. Aim for the longest distance or the longest time in the air.

3. Experiment with making your own paper. Instructions and ingredients needed for making various types of paper can be found at www.papermaking.net. Test different kinds of paper for their foldability, and play with various types of paper to see what abstract objects you can make.

4. Participate in Stanford University's Folding@home project, in which your computer will join thousands of others in running a piece of software that will help scientists unravel the mystery of protein folding. More information on how you can participate in this effort is at http://folding.stanford.edu.

5. Try the fold and cut exercise discussed in the film to discover what can result. For starters, follow the instructions for making the vintage movie camera specially designed by Erik and Martin Demaine for the Community Cinema screenings of BETWEEN THE FOLDS available for download at www.pbs.org/independentlens/between-the-folds/getinvolved.html.

6. Try folding a peacock designed by Robert J. Lang available for download at www.pbs.org/independentlens/between-the-folds/get-involved.html.

7. Look for folds, folded objects and things made or manufactured by folding in your home, workplace and community. Note how many there are and challenge members of your family to see how many different folded items they can find on their way to school or work or on a family trip.

8. Read about Sadako Sasaki and the story of 1,000 paper cranes at www.origami-resource-center.com/sadako/html.

9. Check out http://lists.digitalorigami.com/mailman/listinfo/origami, the online paperfolding listserve where the most current origami chatter takes place. The listserve is welcoming of newcomers and all skill levels.

For additional outreach ideas, visit communitycinema.org. For local information, check the website for your local PBS station.

RESOURCES

General

www.greenfusefilms.com–Explore the BETWEEN THE FOLDS website, which contains press articles, photos, a blog and additional information about the film.

www.origami-usa.org–The website for this American society devoted to origami provides a range of resources for the origami aficionado, including events, publications and online shopping.

www.maa.org–The website for the Mathematical Association of America provides programs, publications, and resources for math enthusiasts, students and math educators

www.origami-resource-center.com/index.html–This online resource center contains information on dozens of types of origami and related arts, diagrams, classroom projects and origami organizations and conferences.

www.britishorigami.info–The British Origami Society is an organization devoted to the art of paperfolding. The website contains historical information, essays by origami artists, a glossary, origami jokes and much more.

Paper & Paperfolding

www.origami-club.com/en–Learn how to make scores of origami figures with both diagrams and animation showing how to fold them.

www.bestpaperairplanes.com–This site contains 10 original origami paper airplane designs, with instructions on how to fold them.

www.funsci.com/fun3_en/paper/paper.htm–This Fun Science Gallery site contains a history of paper and illustrated instructions for making paper at home.

Selected Artists & Scientists

www.langorigami.com–Explore paperfolding artist Robert J. Lang's website, includes a gallery of his work along with information on the connections between origami, math and science.

http://scienceontap.blogspot.com/2009/07/origami-and-math_17.html–In this video, Robert J. Lang talks about the relationship between origami, math and science.

www.popsci.com/scitech/article/2009-04/math-art-and-origami-mit–Read the article "Math, Art, and Origami at MIT" by Emily Stone, which explores fun as a driving force in the work of Erik and Martin Demaine.

Science & Math Applications

http://folding.stanford.edu/English/Science–This Stanford University site explains protein folding and offers the opportunity to become involved in a distributive computing project to help in the study of protein folding.

www.sciencedaily.com/releases/2009/08/090806141524.htm—This August 2009 Science Daily article, "Nanoscale Origami from DNA," discusses work by German and American researchers in developing nanoscale tools.

www.newscientist.com/article/mg20227075.000-nanoscale-origami-folds-dna-into-medicine-cabinet.html—This May 2009 New Scientist article, "Nanoscale origami folds DNA into 'medicine cabinet," talks about the development of a structure that could potentially deliver drugs through the bloodstream sometime in the future.

www.rsc.org/chemistryworld/News/2009/August/06080901.asp—This article, "Nanoscale Tools from DNA Origami," from the Royal Society of Chemistry describes the importance of the work being done in DNA origami.

http://mars.wnec.edu/~thull/origamimath.html—Tom Hull's origami math site which includes links to an Origami Math bibliography and YouTube channel.

Additional Reading:
Origami From Angelfish to Zen by Peter Engle
Origami Design Secrets by Robert J. Lang
Kusudama Origami by Tomoko Fuse

BETWEEN THE FOLDS WILL AIR NATIONALLY ON THE EMMY® AWARD-WINNING PBS SERIES *INDEPENDENT LENS* IN DECEMBER 2009. CHECK LOCAL LISTINGS.

BETWEEN THE FOLDS was directed by Vanessa Gould and executive produced by Sally Rosenthal. The Emmy® Award-winning series *Independent Lens* is jointly curated by ITVS and PBS and is funded by the Corporation for Public Broadcasting (CPB) with additional funding provided by PBS and the National Endowment for the Arts.

ITVS COMMUNITY is the national community engagement program of the Independent Television Service (ITVS). ITVS COMMUNITY works to leverage the unique and timely content of the Emmy® Award-winning PBS series *Independent Lens*. Its goal is to build stronger connections among leading organizations, local communities and public television stations around key social issues and create more opportunities for civic engagement and positive social change. To find out more about ITVS COMMUNITY, visit www.communitycinema.org

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