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Solstice: An Electronic Journal of Geography and Mathematics

Volume XXX, Number 1
June 21, 2019

And the beat goes on...
SAVE A LIFE... with a BONUS USE of your pacemaker, once you are gone, for someone in need!

Project My Heart / Your Heart:
http://www.myheartyourheart.org/

Founded: 1990
Persistent archive: Deep Blue, University of Michigan
Mathematical Geography (Institute of);
Non-persistent archive (first 28 years):
Institute of Mathematical Geography

30 years of SOLSTICE:
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SOLSTICE:

An Electronic Journal of Geography and Mathematics

30 YEARS OF PUBLICATION!

Persistent URL: **http://deepblue.lib.umich.edu/handle/2027.42/58219**

Cite articles as: Author name(s), Year. Title of article, *Solstice: An Electronic Journal of Geography and Mathematics*, Vol. YY, No. ZZ. Ann Arbor: Institute of Mathematical Geography.

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Frontmatter

Solstice was born digital in 1990, before the advent of the Internet. Early volumes were typeset using the digital typesetting language, TeX. The digital files were sent to subscribers via email and the receiver printed out the TeX code, if desired, to produce a typeset-quality journal, on-demand. Selected monographs in the IMaGe Monograph series contain typeset versions of *Solstice*, printed from the code transmitted as the original version of that issue of *Solstice*. Later, when the Internet became available, *Solstice* switched to the Internet as the platform for transmission, writing documents in html rather than TeX.

Early in *Solstice's* production history, some authors worried that their electronic files could be maliciously altered by random readers and uploaded to replace their own writings. Of course that could not have happened (because everything was passworded). However, as reassurance to prospective authors not yet familiar with the mechanics of servers and such, early documents were edited to introduce deliberate errors in spacing, inserted by hand, that a random word-processed document would fail to automatically duplicate. Hence, a bogus copy could be detected simply by overlaying a 'new' printout on the 'old' printout on a light table. The hand-insertion of erroneous spaces motivated the oriental rug motif, photographed from a bokhara rug from the 1964 New York City World's Fair; that symbol is carried forward (although the practice itself is not) in *Solstice* today, as a subtle reminder of one element of the journal's history.

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Persistent URL, University of Michigan Deep Blue Archive (housed under 'Communities & Collections', 'Mathematical Geography (Institute of)': **http://deepblue.lib.umich.edu/handle/2027.42/58219**

Transient URLs that point to the persistent URL: imagenet.org; mathematicalgeography.org; mathematicalgeography.com; instituteofmathematicalgeography.org; instituteofmathematicalgeography.com

AUTHORS OF ORIGINAL MATERIALS APPEARING IN SOLSTICE, 1990-present:
Ainslie, V. | Albert, D. | Ard, K. | Arlinghaus, D. E. | Arlinghaus, S. L. | Arlinghaus, W. C. | Arlinghaus, W. E. | Austin, R. F. | Baird, N. D. | Bandyopadhyay, G. | Barmore, F. E. | Barr, D. | Batty, M. | Beal, F. J. | Beier, K.-P. | Bhatia, S. S. | Blake, B. | Borgers, A. W. J. | Burkhalter, B. R. | Chattopadhyay, S. | Chaudhuri, S. | Childers, P. E. | Chirapiwat, T. | Crane, J. | Crawford, T. C. | De la Sierra, R. | Derudder, B. | Dison, A. C. | Drake, W. D. | Eagle, K. A. | Earl, E. | Favro, R. | Frank, A. I. | Gober, C. | Goodman, F. L. | Gorstein, J. | Griffith, D. A. | Haidar, S. | Hall, B. | Hall, D.| Hamilton, R. C. | Han, S.-H. | Harary, F. | Haug, R. | Haynes, D. | Hoffman, L. L. | Hogh, G. | Iyer, S. D. | Jacobs, D. A. | Kaur, K. | Kelbaugh, D. S. | Kerski, J. | Kim, E-Y. | Koenig, R. | Kos, S. | Kwon, T. | Lach, A. | Larimore, A. E. | Laug, A. | Lazzaro, A. A. | Lee, H. | Licate, J. A. | Maeda, J. | Martin, P. | McCloskey, J. C. | Metzler, D. | Mokray, G. | Muhilal | Naud, M. | Noguchi, M. | Nystuen, J. A. | Nystuen, J. D. | Onstott, B. | Oppenheim, P. J. | Oswalt, K. S. | Pak, S. | Phillips, L. R. | Pogany, T. | Ponce de Leon, J. S. | Pothukuchi, K. | Purvis, E. M. | Ram, B. | Rayle, R. | Robinson, Craig | Rosenblum, A. | Ryznar, R. | Sammataro, D. | Schlossberg, M. | Schumann, L. | Stern, H. L. | Tarwotjo, I. | Tilden, R. | Timmermans, H. J. P. | Tobler, W. R. | Van Acker, V. | Wagner, T. | Wallace, R. | Walton, A. | Ward, M. | Wilson, M. L. | Witlox, F. J. A. | Woldenberg, M. J. | Zander, R. H.

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Application Gaps: From Discovery to Use.

Sandra L. Arlinghaus

Introduction: Gap between Discovery and Use

The gap between the discovery of pure mathematical ideas, concepts, and theorems, and their use in the real-world is a well-known and long-standing fact; it is also one that becomes periodically neglected as practitioners of real-world disciplines adopt and modify an existing application rather going back to the primary source of the pure theory to create their own application.

In this article, a number of well-known gaps are cited as well as gaps noted in works of this author. The editor invites others to submit more gaps for constructive continuation of this discussion, either existing well-known ones or lesser-known ones, to form a sort of 'Gap-a-logue' for reference purposes.

A Few Well-known Existing Gaps

Prime factorization.

Eratosthenes Prime Number Sieve dates from antiquity and reflects the fascination with divisibility that has endured since those times as it offers a method for casting out non-primes from a display of integers greater than 1. What remains, following casting out, is a pattern of prime numbers (link to animated display).

The Fundamental Theorem of Arithmetic states that every integer greater than 1 is itself a prime number or can be uniquely decomposed into a product of prime numbers. For example, $75=3 \times 5^2$. Or, $72=2^3 \times 3^2$. For one exposition of matters related to this topic see Spatial Synthesis: Centrality and Hierarchy, Volume I, Book 1. Ann Arbor: Institute of Mathematical Geography, Chapter 3. For general reading, see the cited works by Niven et al.

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Justin Rising notes, in a recent comment in Quora, “Prime factorization has been studied since roughly 300 BCE, and was first applied to cryptography so recently that many of the people involved are still alive.”

The gap from Eratosthenes to cryptographic application is gigantic!

Set theory. The concepts underlying set theory may be as old as the rational human mind: the family is a set. As a formal study, however, set theory has a relatively compact history dating from the time of Georg Cantor and Richard Dedekind in the late nineteenth century. By the mid-twentieth century, set-theoretic concepts were reshaping approaches to mathematics (Birkhoff and Mac Lane, 1941). Later, application of the newer approaches to mathematics, involving set theory, found their way into disparate other academic fields. For one approach to more discussion on this gap, see a recent NCGIA publication (Arlinghaus, S. L. (2019). Set Theory. *The Geographic Information Science & Technology Body of Knowledge* (2nd Quarter 2019 Edition), John P. Wilson (Ed.). DOI: 10.22224/gistbok/2019.2.1).

Fractal Geometry. Fractal geometry is based on space-filling ideas that date from the 1890s and earlier. Computer visualization has permitted advancement of space-filling to see 'fractional dimension' and related concepts and to interpret them in a wide variety of real-world settings.

One early article (1989) uses fractal geometry and self-similarity to geometrically generate entire central place hierarchies associated with arbitrary Löschian numbers (Figure 1) (Arlinghaus, 1985). In Figure 1a, one sees the beginnings of the fractal generation of a K=4 central place hierarchy; successive stages in the iteration are suggested in Figures 1b. The reader is guided through a QR code and link in Figure 1c to detail of the process, including animated graphics.

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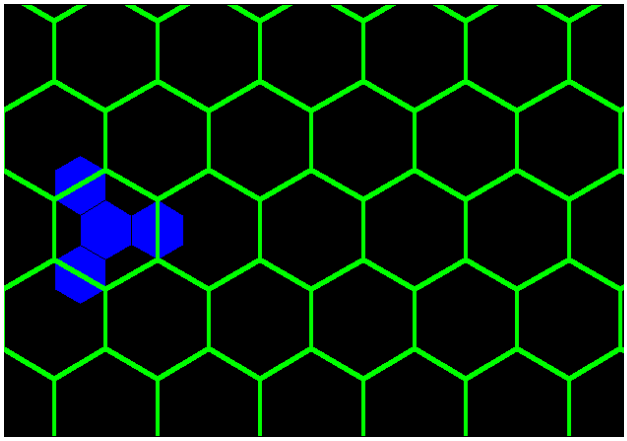

Figure 1a. *K*=4 central place hierarchy generator to be scaled and employed successively.

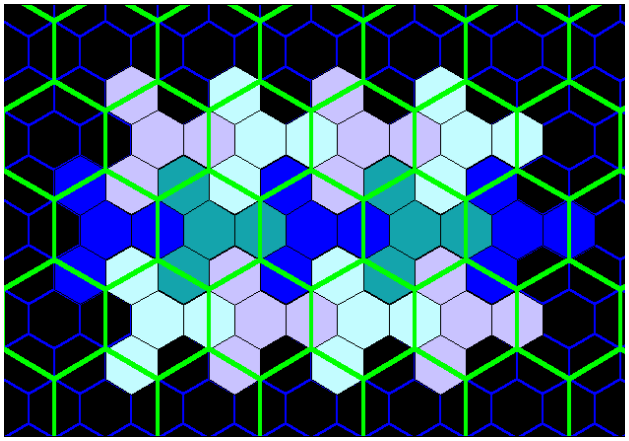

Figure 1b. Translation of generator to indicate pattern at a single level of fractal hierarchy.

Source of illustrative figures:

http://www-personal.umich.edu/%7Ecopyrght/image/books/Spatial%20Synthesis2/chapter2.html

Figure 1c. QR code and link to materials showing detail of process and animation of process.

Selecting correct shapes to generate fractal forms is what determines the central place hierarchy with successive iteration of generator application. The art, as is the case in geometric fractal forms, rests in visualization; the science rests in the number-theoretic properties of the central place hierarchy and patterns of urban separation. Here, a custom-fit of foundational forms is tailored to a theoretical urban application to solve

broadly-conceived problems on how cities share space. Yet other urban applications, developed around the same time, focus on fractal forms within actual urban settings, as in the fascinating work of Batty and Longley (1994). Urban fractal applications continued developing into far-flung research agendas through time. The concept of fractals, derived from set theory, geometric space-filling, and self-similarity, has served as a rich and rewarding research area for many in the GIS and other worlds. The gap from Peano in the late 19th century to today began to experience its own space-filling pattern a mere century, or so, later.

Lesser-known Gaps

Projective Geometry

Projective geometry is a non-Euclidean geometry that sits over other non-Euclidean geometries. It is general and possesses complete symmetry. The infinite is no different from the ordinary; two points determine a line and two lines determine a point. "Parallel" lines intersect at a point at infinity. There is complete duality.

The constructions of projective geometry, which are quite beautiful, remain hidden from the Euclidean-trained minds of many. The observations appear "unnatural" and "non-intuitive;" animation can bring them to life.

One article employs harmonic conjugacy in association with true perspective projections of the globe to a mapping plane. The result is animated showing how all perspective mapping is captured by this single projective geometric construction! That is, the entire set of perspective projections may be derived in the projective plane, alone, from the subset of projections with centers of projection contained within the sphere of projection. The unbounded problem of looking at an infinity of projection centers spread along an unbounded ray is converted to one of looking at an infinity of projection centers spread along a bounded line segment (Arlinghaus, S., Geography/Geometry--Visual

Unity, 2007, Solstice, Volume XVIII, Number 2,).

The language of duality of projective geometry then applies to the geometry of all perspective map projections. This geo/metric/graphic unity of harmonic conjugacy and perspective projection suggests possible advantages in employing this highly symmetric geometry, that does not distinguish the ordinary from the infinite, to understand and to analyze other geographical problems that exhibit symmetry in underlying relations and that also embrace the concept of infinity.

Category Theory

Category Theory is a mid-20th century language that visualizes the unity of mathematics as it economizes on thought and expression. It may expose unseen connections among disparate branches of mathematics. A result that is proved in category theory may generate numerous results in a variety of subordinate mathematical areas as when categories are mapped to each other revealing otherwise unknown solution to seemingly difficult or intractable problems.

A mathematical category is an abstract concept that deals with mathematical structures and the relationships connecting them—as objects and arrows. Categories can offer a unifying framework of a high level of abstraction in which to place large amounts of information about both the objects and the arrows/relationships. The most important property of the arrows is that they can be "composed", that is, arranged in a sequence to form a new arrow. What are the implications of this shift in focus for geographical analysis and synthesis (Arlinghaus and Kerski, 2014)?. The key is that here arrows dominate: here, as in life, connections matter.

Sheaf Theory

Category theory is a general, abstract mathematical language that may be useful in simplifying complicated systems; so too is sheaf theory. The idea in sheaf theory, very

generally, is to take a complicated space, not fully visible or comprehensible from any vantage point, and to learn about its full general structure by looking at a system of local observations that can be uniquely glued together to create a global observation of the entire space.

Sheaf theory has not yet seen wide application. Interesting examples appear in the literature in several disciplines. One application, which notes others, appears in the engineering and computer science world of air traffic control--certainly a complicated space not readily envisioned in any traditional sense (Seyed Mansourbeigi, 2017, Sheaf Theory Approach to Distributed Applications: Analysing Heterogeneous Data in Air Traffic Monitoring, International Journal of Data Science and Analysis, http://article.sciencepublishinggroup.com/pdf/10.11648.j.ijdsa.20170305.11.pdf)

Broadly viewed, it might seem as if scholars in urban studies of various sorts who are dealing with large data sets might consider a sheaf-theoretic view of neighborhood structures to come to a wider full metro view of sorts...

Topos Theory

Finally, one might consider broaching topos theory, another broad, general, abstract language. A topos is a category that behaves like the category of sheaves of sets of a topological space. In that regard, it is an integrative language that once again might offer an interesting way to combine applications of category theory or sheaf theory to get yet a more abstract view of the situation thereby revealing otherwise unsuspected research directions.

Additional Reading, mostly hard copy in addition to links in the text.

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Words Matter!

Sandra L. Arlinghaus, William E. Arlinghaus, Kim A. Eagle, Thomas C. Crawford, E. Michael Purvis, Matthew Ward, Derek Haynes, Jay Crane

The pen is mightier than the sword.
Edward Bulwer-Lytton, 1839.

Words Matter! Indeed. Ask any politician or anyone whose reputation has been falsely smeared on a social media website. It takes work to undo what has been done. Look at conventional retractions, sometimes appearing on page 12 of a newspaper two weeks after an initial accidentally erroneous report on the front page. What do people remember? Do they even find the retraction?

Beyond these well-known instances of words causing difficulty, an unusual instance of it arose in spreading the word of an altruistic project. Readers of *Solstice* who have followed various aspects of Project My Heart / Your Heart at the University of Michigan, might be surprised to learn that we recently uncovered a case of a linguistic problem associated with disseminating information through our Mississippi connections (that may well translate elsewhere). To begin, we will repeat a bit of material about that project that has appeared elsewhere in *Solstice* in order to get all readers on the same page concerning the general nature of that project and why a Mississippi connection is a uniquely important one.

Overview

Project MyHeart / YourHeart, at the Frankel Cardiovascular Center of The University of Michigan, promotes the reuse of the existing pacemaker supply in the United States in developing nations. As that Project's website notes (http://www.myheartyourheart.org/):

> "There is a great disparity between the high and low income countries in terms of pacemaker and defibrillator availability. Each year 1-2 million individuals worldwide die due to a lack of access to pacemakers and defibrillators. Meanwhile, almost 90% of individuals with pacemakers would donate their device to others in need if given the chance. The *Frankel Cardiovascular Center* has been conducting a series of research projects aiming to establish pacemaker and defibrillator reuse as feasible, safe, and ethical means of delivering this life saving therapy to patients with no resources…We must never forget that at the foundation of each technological breakthrough is the need to improve humanity in all aspects of our society. Undoubtedly, pacemaker reuse can safely and effectively transform a currently wasted resource into an opportunity for a new life for many citizens in our world!"

Pacemakers are typically harvested from those who have recently passed away, while they are still in the funeral home. Individuals who wish to be cremated must have pacemakers removed; a pacemaker that passes through a crematorium may cause the crematorium to explode (Puddu, 2015). Thus, funeral homes are one good source of supply of used pacemakers.

However, as noted in the quotation above, there may be as many as 1 to 2 million, annually, whose lives might be enriched and lengthened by getting a pacemaker implanted. The demand side of this equation is huge. The supply side comes nowhere near matching the demand side. Since most people would voluntarily donate, the promotion of public awareness becomes critical, both at the local and global scales.

Dissemination of selected information regarding this project is linked to the Project My Heart Your Heart publications page on the website (http://www.myheartyourheart.org/pub.html). Of particular note in regard to widespread dissemination is the article in a special issue of *Scientific American* which makes special reference to My Heart Your Heart. Readers wishing further detail involving medical issues might refer to the 2017 article by Runge. Further, recent audio and video presentations on the BBC (Focus on Africa, 2018), following successful pacemaker implantations in Africa, will no doubt increase the global demand for pacemakers. According to Dr. Thomas Crawford, Project My Heart /Your Heart and Pace4Life travelled to Sierra Leone and to Kenya during February of 2018 where they implanted a

total of 21 pacemakers and 1 defibrillator and also educated local cardiologists in the procedure. Response from the supply side becomes all the more critical!

The Case of Mississippi

In addition to the economics of supply and demand, there is also the environmental issue of recapturing a resource that otherwise winds up in the waste stream. While cremation mandates pacemaker retrieval, other forms of dealing with human remains do not. With full-body burial, for example, the pacemaker is typically not removed from the body but is buried along with it. Buried pacemakers are resources that are lost forever and the same lithium battery and sealant that might have caused crematorium explosion are now buried in the soil. Neither one of these is a good situation.

To consider enlarging the pacemaker supply, through public awareness, one approach might be to target regions in which the greatest percentage gain in pacemaker recovery is possible: in regions with low cremation rates and consequently high burial rates. At the State level, within the United States of America, the State of Mississippi has the lowest cremation rate (Figure 1, 2015, Kahn and Kirk). In Mississippi, cremation accounted for less than 10% of all processing of human remains while a nationwide level was at over 45% (2015, Kahn and Kirk). It was also the only state below the 10% level and on that metric is clearly the state in which biggest percentage gains through retrieval of pacemakers (otherwise lost and wasted) can be made.

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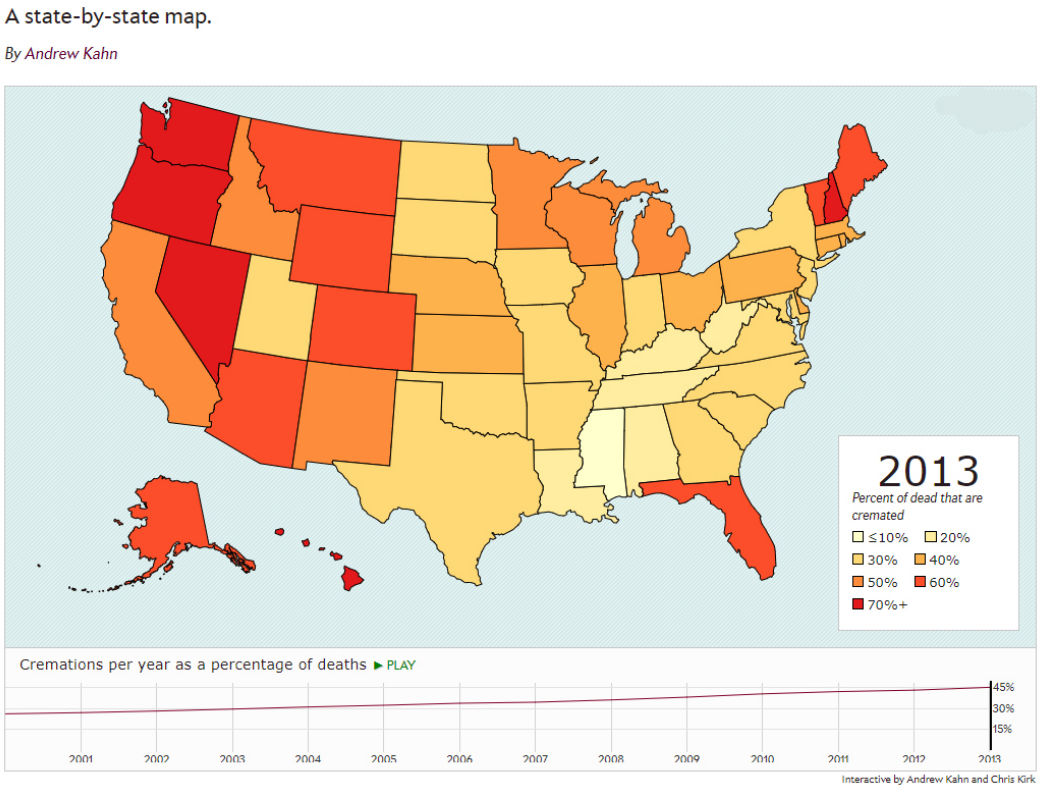

Figure 1. Mississippi has lowest cremation rate in the USA. Single screen capture.

This past year, a team of people, based in Meridian, Mississippi, have worked together to spread the word about pacemaker recycling to encourage those not selecting cremation to consider donating their used pacemakers after death. Arlinghaus assembled a team of people each with substantial contacts, but with small overlap (noted below) with each other.

> Edwin Michael Purvis, MD, is a cardiologist at the Cardiovascular Institute of the South, and has interests in interventional as well as preventive cardiology. Matthew Ward, DO, Family Medicine, the Free Clinic of Meridian. Matthew's population base may overlap, through the process of client referral, with that of Dr. Purvis.

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Derek Haynes, Pharm D., is a pharmacist at Walgreens where he comes in contact with a diverse set of individuals. Derek's target population base will of course overlap some of that of Drs. Purvis and Ward.

Jay Crane. Jay is a native of Meridian. He owns Magnolia Cemetery and has years of experience in the local death care industry, in both the cemetery and funeral businesses. Jay's population base may overlap with any of the three above.

Each team member was given a supply of business cards to distribute that shows contact information for MyHeart / YourHeart so that interested donors can proceed on their own (Figure 2). The team made, and continues to make, the cards available to individuals they come in contact with.

Figure 2. Business card, designed by Arlinghaus employing official MyHeart / YourHeart logo, being distributed to promote awareness in Meridian and elsewhere. Please feel free to download it and print it out and distribute in your own community. Please let us know if you do so; we like to track progress.

Linguistic Variation: A Problem with Project Dissemination?

Within the past month or so, W. E. Arlinghaus discovered, from oral evidence from native local sources (from politicians to medical professionals) that the word 'recycle'

was a ‘red flag’ word for many native Meridianites and perhaps for native Mississippians south of the Memphis metropolitan area. As it was first put to him in no uncertain terms, ‘recycle’ is a word created by ‘hippie Yankees.’ In a part of the country where one might hear reference to ‘The War Between the States’ or to the ‘War of Northern Aggression’, instead of ‘The Civil War’, this indictment was no joke; clearly this word mattered. Hence, the card in Figure 2 was probably not as effective as we had hoped it would be. Discussion with other locals verified the problem.

Further conversation with local folks continued to show that they did not like the word ‘recycle’ and that that word held a strong enough vibe to prevent some of them from even considering taking action with recycling bottles (for instance) and indeed might cause them to flaunt the concept and throw the bottle away as a hostile response to a word they disliked. Moreover, when that word was not used, their thoughtful and genteel nature returned and they were happy to think about other ways to make art out of bottle caps, and so forth. However, when asked for a word that was better than ‘recycle’, none seemed to come to local minds.

Here input from someone from another culture region (with 'fresh' ears) came into play. S. Arlinghaus noticed, in reading real estate descriptions of houses, that some of them had ‘bonus rooms.’ Presumably, those are what she might have called ‘family rooms’. T. Crawford commented that when he had lived in the south, his family had had a ‘bonus room’ and also commented that indeed the culture he had lived in was quite similar to what the Arlinghauses were seeing. In another part of the news, S. Arlinghaus noticed the phrase ‘bonus children’ in an obituary of a man who had died recently. Presumably, that meant ‘step children’ but might have meant ‘adopted children’. In the first instance, there might be negative connotation to the idea of having been a step-father (as in ‘wicked step-father or mother’). The word ‘bonus’ apparently made things acceptable. So, she asked contacts of W. Arlinghaus how they would react to the phrase ‘bonus use’ instead of ‘recycle’. Responses included ‘I love it’, ‘that’s MUCH better’, and ‘no one could possibly be offended by that.’ Well, time will

tell. But clearly a change in the cards that solicit used pacemakers, to remove 'recycle' and insert 'bonus use', is called for (Bonus Use Resource Center website, 2019)! Figure 3 suggests such a card.

Figure 3. Revised card.

As K. Eagle noted, with characteristic good humor in underscoring interesting uses of language, 'Certified Previously Owned might be one phrase to adopt?' Stay tuned; we shall see if language adjustment generates even greater local interest!

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A Sample of the Earth, One Point at a Time

Joseph J. Kerski, PhD, GISP

After driving until the road ends and then hiking for hours, you arrive at your goal. Are you atop a mountain peak, at a cave's entrance, or at a rare fossil dig? No, you are at a degree confluence point. There is no band, victory tape, not even a marker. You are likely to be standing in a field alongside some bored-looking cows. But you are on a unique point, where a line of a full degree of latitude intersects a line of a full degree of longitude. Through the Degree Confluence Project (DCP) (www.confluence.org), people around the world journey to these points and document what is there. Through these efforts, a true picture of what our planet is like is emerging through this regular sampling of points (Figures 1 and 2).

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Figure 1. Ground cover at different latitude and longitude confluence points in, clockwise from upper left, Texas, England, California, and Nebraska.

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Figure 2. Biomes: View of latitude longitude confluence points in, clockwise from upper left, California, North Carolina, Nevada, and New Zealand.

By the 21st Century, humans had explored just about every conceivable place. Yet the spirit of discovery is far from dead, and today's explorers are still as tenacious as those of yesteryear. Journeying to latitude-longitude intersections is a perfect example. To be "on point" means within 100 meters of these intersections for the visit to be considered complete. A visitor to 70° north latitude, 29° east longitude stood on the shoreline 110 meters away, gazing across a chilly fjord in Norway. The visit was listed as incomplete, prompting the next visitor to swim to the point using a wet suit!

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Hunting for “confluence points” fits squarely within GPS-based hobbies, such as geocaching, earthcaching, geodashing, and those finding boundary corners and triangulation stations. Yet it is different from all of them. First, the points are fewer in number, and many are difficult or dangerous to reach, or are on restricted lands. While geocaching.com listed 260,000 visits by nearly 40,000 visitors during a single week in December 2007, over the past 20 years, just over 13,000 visitors have journeyed to about 7,500 confluence points. Second, confluence hunting is primarily a scientific, not a recreational, endeavor.

Have you ever looked at a paper map, globe, or digital map in your GIS and wondered, “what exists on the ground where these latitude and longitude lines intersect”? In 1996, 21-year-old computer programmer and entrepreneur Alex Jarrett passed near 43 00’ 00” North and 72 00’00” West on his daily commute in New Hampshire. Wondering what would be at that spot, he and a friend journeyed there on bicycles with Alex’s new GPS receiver, and posted their photos to Alex’s new website. Others began visiting points where they lived, and the website soon had to be moved to a larger server with full database capabilities. Regional coordinators were recruited, and the project became a perfect example of neogeography, or volunteered geographic information, or citizen science.

On Earth, 64,442 latitude and longitude degree intersections exist, with 14,029 on land. Just over 2,000 are in water within sight of a shoreline, with 151 on an ice cap. By 2009, there were still over 6,000 on land yet to be found. Your nearest confluence is closer than 49 miles (79 km) away. If you feel inclined to visit one, secure permission if you will be accessing private land, bring batteries, a GPS and/or smartphone, and standard survival gear. Colin Irvine and Ken Long visited 18 ° North 46 ° East, describing the Empty Quarter of the Rub’al-Khaliy in Saudi Arabia as “a nice neighborhood which has no rush hour traffic and one of the lowest crime rates on the planet.” Besides the GPS, the 75 kilograms of ice that they had purchased certainly helped.

Given the movement of the Earth and the movement of GPS satellites, along with the inaccuracies of triangulation, stepping left, right, forwards, and backwards in order to capture the moment at which all of the decimals on the GPS equal zero may look strange to an observer. If the point is under heavy tree cover, in a canyon, or near buildings, the explorer may never actually achieve the moment of zero nirvana.

People have skied, hiked, sailed, kayaked, motorboated, freighted, and even dove to reach these points. They have used ultralight aircraft, helicopters, snowmobiles, trucks, cars, buses, taxis, rickshaws, taxis, all-terrain vehicles, dogsleds, motorcycles, and other means to reach the points. The highest confluence point is considered to be 30° North 81° East in Nepal, near India and China's borders, at 5,845 meters (19,177 feet). This was attempted by Greg Michaels and Mitch Dion in 2008. After weeks of preparation and alpine skiing to within 37 km of the point, government officials forced them to turn back, and they even had to escape a drunk doctor on the way down. However, Greg Michaels and Robert Whitfield did successfully visit the second highest confluence point, at 33° North 80° East in Tibet, in 2005, costing them 11 days and very nearly their lives. The planet's lowest point, at 78 meters below sea level, lies at 30° North 27° East in Egypt, is far easier to visit. The highest confluence point in the USA lies near the summit of Mount Wrangell, Alaska.

I have attempted perhaps the world's steepest confluence point, at the rim of the Grand Canyon, at 36° North 112° West. A national park ranger, is, appropriately, the only successful visitor to this point so far. The trek that Dr Shannon White and I made to 41° North 112° West, wading up to our waists in the Great Salt Lake, was certainly my wettest point (Figure 3). But Matt Taylor had us beat, stepping through chest-deep waters in a lake in Alaska to reach 62° North 150° West. On the other end of the climate scale, a visit to the driest place on Earth at 19° South 70° West in South America revealed surprising sculptures.

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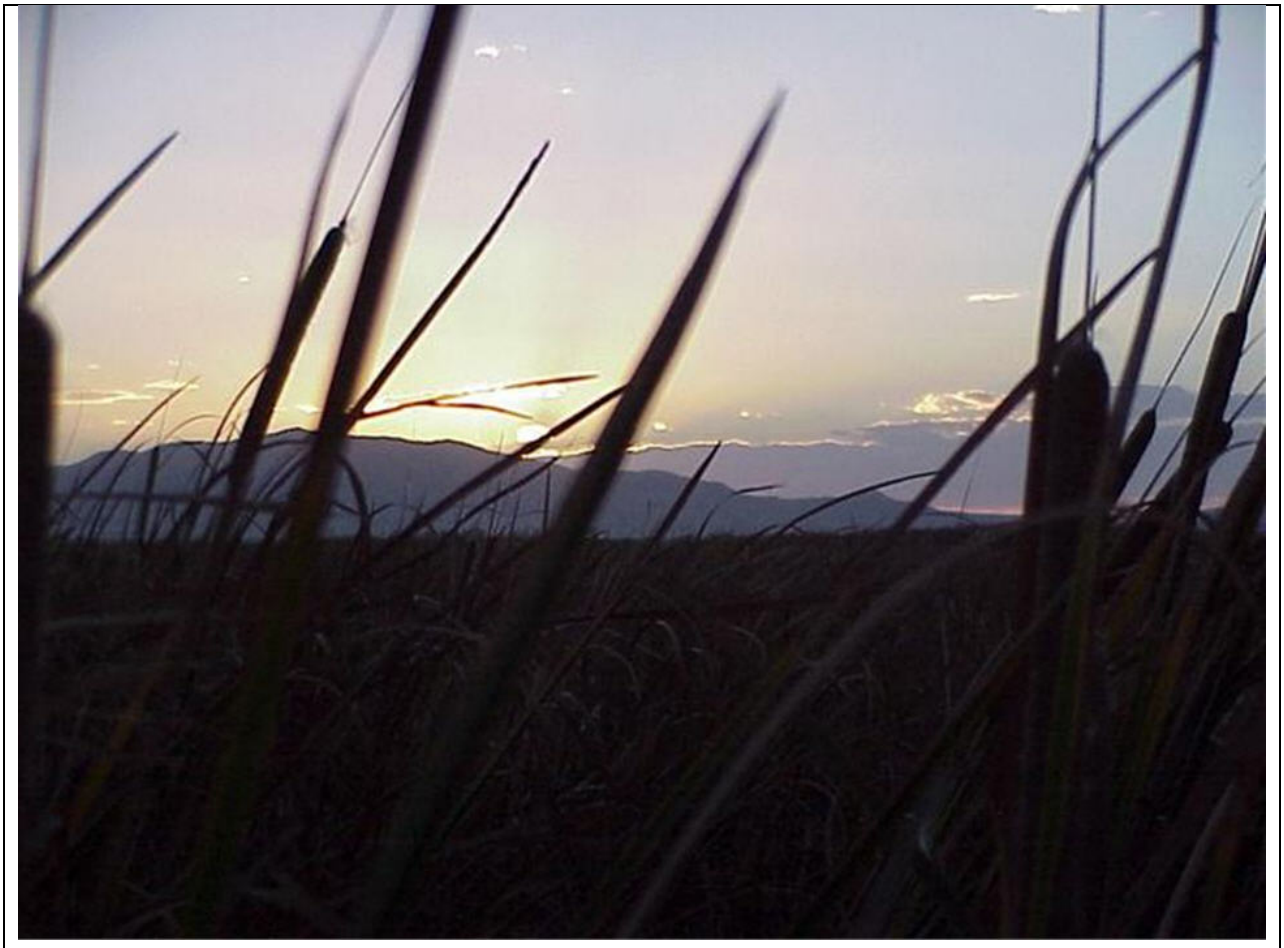

Figure 3. Sun setting over the Great Salt Lake at 41 North 112 West.

A volcanic view makes 8 South 113 East in Indonesia one of the most beautiful, along with the view down Kjerkefjord in Norway at 68 North 13 East. The most beautiful that I have visited may be 39° North 107° West in Colorado (Figure 4) or the yellow field of canola at 52° North 0° in England (Figure 5).

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Figure 4. Wilderness sign at 39 North 107 West in Colorado.

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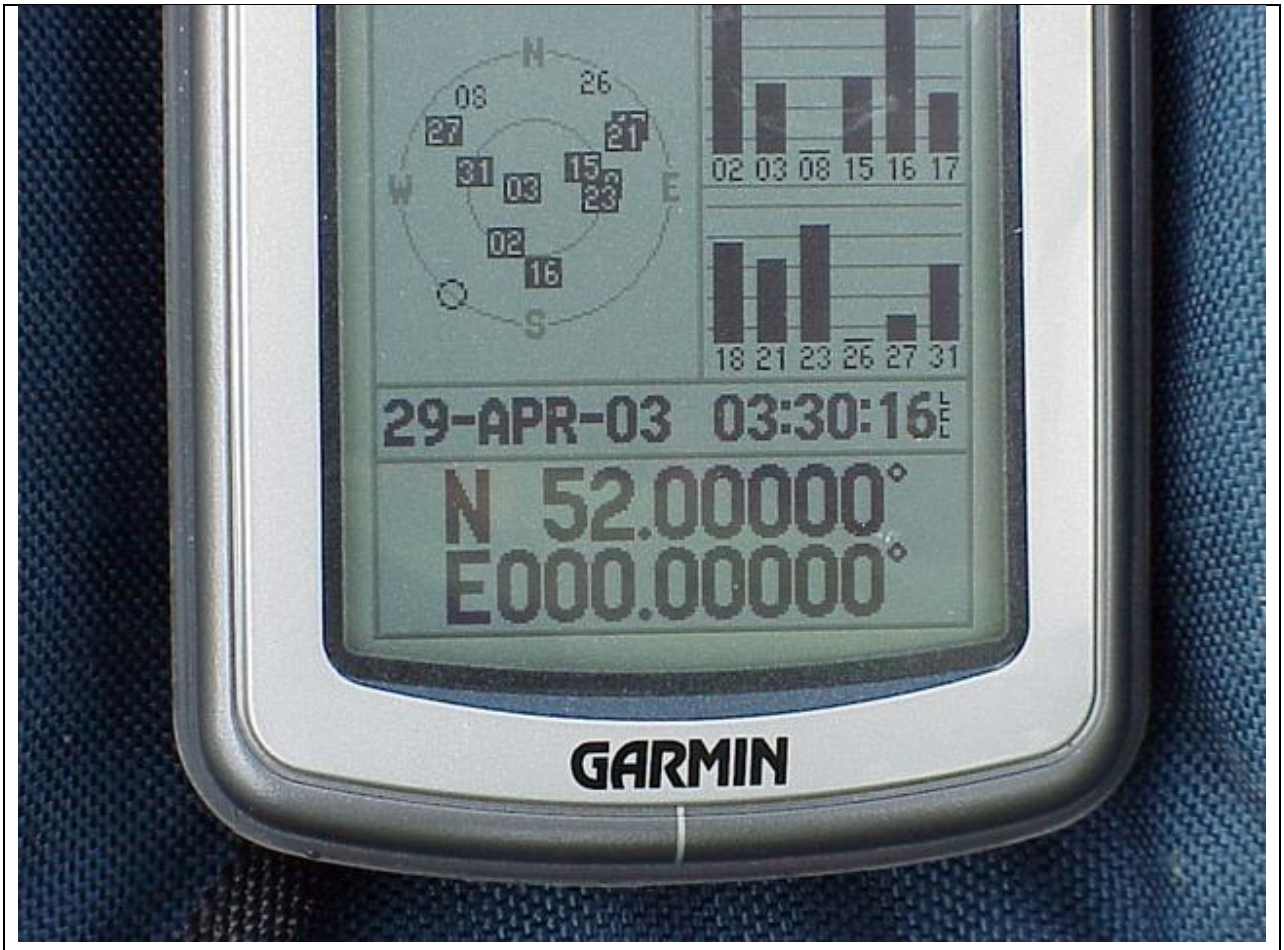

Figure 5. GPS receiver at 52 North on the Prime Meridian in England.

The levee behind an industrial park at 30° North 90° West in New Orleans may have been my "creepiest" point. The loudest might be 40 North 83 West near The Ohio State University. And during 2006, while wandering a new subdivision in Virginia, I found out that $699,900 could have bought the land on which 38° North 79° West sits.

This project reveals some insights about our planet. While human impact is evident at thousands of points, we haven't yet paved over the entire surface. Remote points still exist, such as 21° South 26° East on Sua Pan in Botswana. The visitors reached it by quad bike after their vehicle became stuck. My own loneliest point was 33° North 97°

West in a half-abandoned industrial park in Dallas. The most hazardous was my guard-escorted trek to a power plant outside of Mobile, Alabama. I declined to wade into the asbestos dump for the final 200 meters.

Following the North and South Poles, 0° 0° is probably the most famous point. The crew of the US Coast Guard Cutter *Sherman* passed within 1,014 meters of this spot in 2001, jumping into the Atlantic Ocean to celebrate. In 2007, I journeyed 1,100 miles along 38 and 40 North Latitude to visit seven confluence points in Kansas and Colorado in one day. Rainer Mautz and Elionora visited 10 points in Europe in one day, matched by David Coombs who stated that the lack of speed limits on many German highways certainly helped.

Murray and Christine Grainger were the first to log visits to the opposite sides of the world, the antipodes, in Spain and New Zealand, choosing the date 03-03-03 to finish off the pair at 37° North 5° West, and 37° South 175° East, just to “make it a little more special.”

Lawrence and Seng left an Internet conference for a nighttime tromp to 4° North 102° East in Malaysia. They encountered a swamp, leeches, thistles, heat, exhaustion, and border guards, and lost their glasses and a leather business card holder to boot. Rainer Mautz was escorted by police to 14° North 44° East in Yemen. A military escort accompanied me to 4° North 78° West on a base in North Carolina. The group motoring in a Land Cruiser across the Sahara in Algeria toward the border with Niger after finding 23° North 10° East was stopped by a group of armed men. Fortunately, the men gave them bread, cookies, and yogurt. Greg Michaels’ quest for the last four points in Bosnia and Herzegovina was riddled with land mines. A black mamba snake came centimeters from killing one of the 7° North 2° West explorers in Ghana. But the group trudged onward to 6° North 3° West, only to be assaulted by a swarm of army ants. Polar bears were seen by those traveling to Svalbard, Norway, while Magne

Svensen walked to 4° South 36° East amongst carnivorous animals in the Tarangire National Park, Tanzania.

Peter Mosselberger found an idol fence at 5° North 7° East in Nigeria which read, “If you enter this territory without properly sacrificing an animal, you’ll be afflicted with an incurable sickness.” Peter declined to enter.

This project adheres to the leave no trace creed and asks that all visitors ensure that they secure permission to enter private land. There are, however, some permanent markers at a few points. 50° North 6° East in Luxembourg is marked by a steel pole, 35° North 135° East is marked as the “navel of Japan”, and a wooden sign is planted in a Wisconsin field at 45° North 90° West. These markers may have been surveyed using different datums and may not be on the true confluence point as measured today. Datums matter! I was, however, pleased to find that William Clark’s mark in 1806 on Pompey’s Pillar in Montana is surprisingly close to 46° North 108° West!

My visits to over 400 points across the planet have brought me to out-of-the-way places and allowed me to meet and travel with wonderful people. I have traversed grasslands with the Rosebud Sioux Tribe’s Land Officer, trekked through the Michigan woods with a funky dune buggy, and hiked through the Colorado forest with a magazine editor. I have walked along the Prime Meridian with a geography professor, crawled through Texas thorns with a GIS analyst, and walked the Santa Fe Trail with a park ranger. I have shadowed the footsteps of Lewis and Clark with a USGS cartographer, conversed with local farm animals with a Missouri Botanical garden educator, and motorboated on the Gulf of Mexico with a university biologist. And I treasure the local folks: Good humored elderly gentlemen in Alabama, the odd character living in a combination curio shop and junkyard in Texas, fishermen who took me into the English Channel, New Zealand dairy farmers, and college students playing in a kiddie pool.

The project offers means of examining location, place, human-environmental interactions, movement, and regions. What forms of dwellings, crops, trees, grasses,

and businesses exist? What is the weather and climate like? What water exists, and in what forms? What human and natural forces are acting to change the landscape, and how will it look in another generation? You may be, through the project's website, surprised to find rocky cliffs in Saudi Arabia, rainforests in the USA, and cacti in Russia. The project shows what places are *really like,* not what tourist brochures show, and not what it is like where people live. The project also provides a research tool for verifying land cover. Wander on the website along a latitude or longitude line to observe changes in vegetation, landforms, and change over time, such as before and after a wildfire in Russia and as Las Vegas urbanization creeps closer to the confluence point. Imagine a creepy haunted house in a moonlit Nebraska October evening (Figure 6), or riding a horse across miles of New Mexico desert (Figure 7). The project's site can therefore be used to teach about human geography, physical geography, earth science, biology, history, oceanography, and mathematics as well as to motivate interest in these subjects through imagination.

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Figure 6. Full moon setting over 41 North 100 West in Nebraska.

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Figure 7. Confluence of 35 North 105 West in New Mexico.

From Iran to Mexico, people have opened their homes to the explorers. A confluence is a “flowing together”; the project is a meeting of the global community, to encourage stewardship for the land and respect for its people. To touch these points is to connect to the International Meridian Conference in 1884. Humans are explorers. They want to explore with a goal, even if that goal is to visit an arbitrary point defined by lines set down by people long since departed. Even if the final point is never reached, the project has created a global database that provides a portrait of our planet like no other.

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Video Narrations of some Gelman Dioxane Site Concerns

Roger Rayle

It's time I shared these short video narratives of some Gelman dioxane site concerns more widely. Readers of *Solstice* might remember a variety of earlier animated images that appeared elsewhere in this journal. Such readers might also be interested in my chapter in a forthcoming book, *Spatial Thinking in Environmental Contexts: Maps, Archives, and Timelines*.

These linked videos relate to the dioxane moving through narrow plumes under the 3365 Jackson Rd parcel (the site of the proposed Lockwood development) and northward towards 465 Dupont and beyond. They are examples of how 21th century tools like Google Earth and image stitching can help stakeholders identify otherwise hidden issues using open, linked data.

20180603-Narration_Lockwood D2 plumes https://youtu.be/majKXjPBEfQ
20180603-Narration_Gelman dioxane plumes under proposed Lockwood Development site https://youtu.be/NU8KgXiKXwU
20180603-Narration_465 Dupont plume https://youtu.be/86VUi2qg4LI

They speak to concerns about our understanding of what's really happening at the site:

20170814-Narration_ WellTrends-concerns-TW-14_TW17
https://youtu.be/BpSHRI-G_es?t=15
20170815-Narration_MW-1_ppb up_replaced
https://youtu.be/uXTJ_RJtv4Q?t=17
20170815-Narration_465 Dupont elevation errors
https://youtu.be/BMINUqP3_Bw

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I plan to set up group work sessions for stakeholders interested in learning how to navigate SRSW's Google Earth mashups & other resources about the Gelman site. so they can make similar video clips.

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Note from Joseph Kerski

Recently, Board member Kerski sent in the following story of odd coincidences—all this from a world-class Mapping, GIS, and Story Map expert!

> You will like this---in March I left winter in Colorado, flew to New Zealand where it was summer, while there I celebrated autumnal equinox, it turned to autumn, I flew back to Colorado where it was spring! 4 seasons, 9 days. THEN I also as an aside flew to the GIS airport – GISborne, NZ. And get this – I was in SEAT 3D.. .3D GIS!
>
> Doesn't get any better than that.

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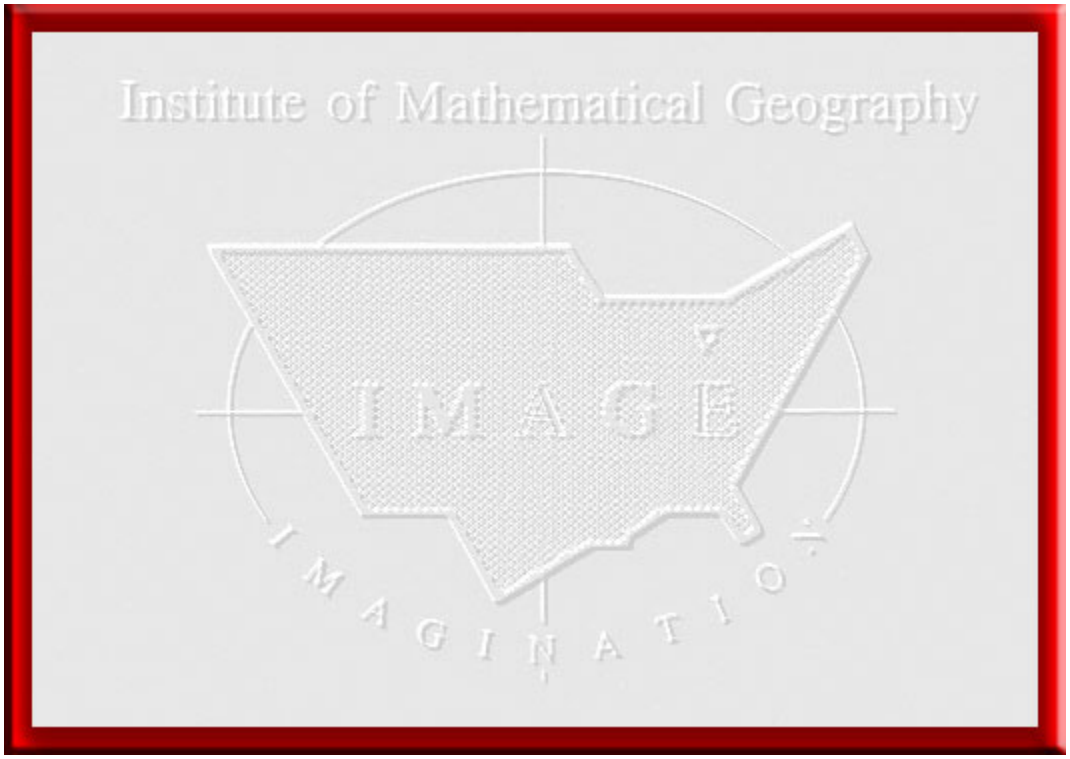
Endmatter



Original logo designed by Sandra L. Arlinghaus and stylized and redrafted by Allen K. Philbrick.

AWARDS AND SELECTED COMMENTS

- ***Solstice* page translated into Belorussian, April, 2016; many thanks to Valerie Bastiaan.**
- ***Solstice* cover materials translated into Ukranian, August 25, 2011; many thanks to Galina Miklosic.**
- ***Solstice* was a Pirelli INTERNETional Award Semi-Finalist, 2001 (top 80 out of over 1000 entries worldwide)**
- **One article in Solstice was a Pirelli INTERNETional Award Semi-Finalist, 2003 (Spatial Synthesis Sampler).**
- ***American Mathematical Monthly*, September 1992, in Telegraphic Reviews section notes *Solstice* as "one of the world's first electronic journals using TeX." L. A. Steen.**
- ***Science News*, 25 January, 1992. Article about *Solstice*.**
- ***Science*, AAAS, 29 November, 1991. Article about *Solstice*.**

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LISTINGS IN DIRECTORIES AND DATABASES

- **IMaGe is listed as a "Collection" in the persistent online archive, DeepBlue, of The University of Michigan library. It is listed under "Mathematical Geography" on the Collections link.**
- ***Solstice* has been listed in the Directory of Open Access Journals (for its first 28 years) maintained by the University of Lund.**
- ***Solstice* is listed on the journals section of the website of the American Mathematical Society, http://www.ams.org/**
- ***Solstice* has been listed in the EBSCO database.**
- **IMaGe has been listed on the website of the Numerical Cartography Lab of The Ohio State University, with thanks to Harold Moellering.**
- ***Solstice* is listed in Geoscience e-Journals, with thanks to Bruno Granier, as in the table below:**

Geoscience e-Journals			
Previous	Random	Next	List