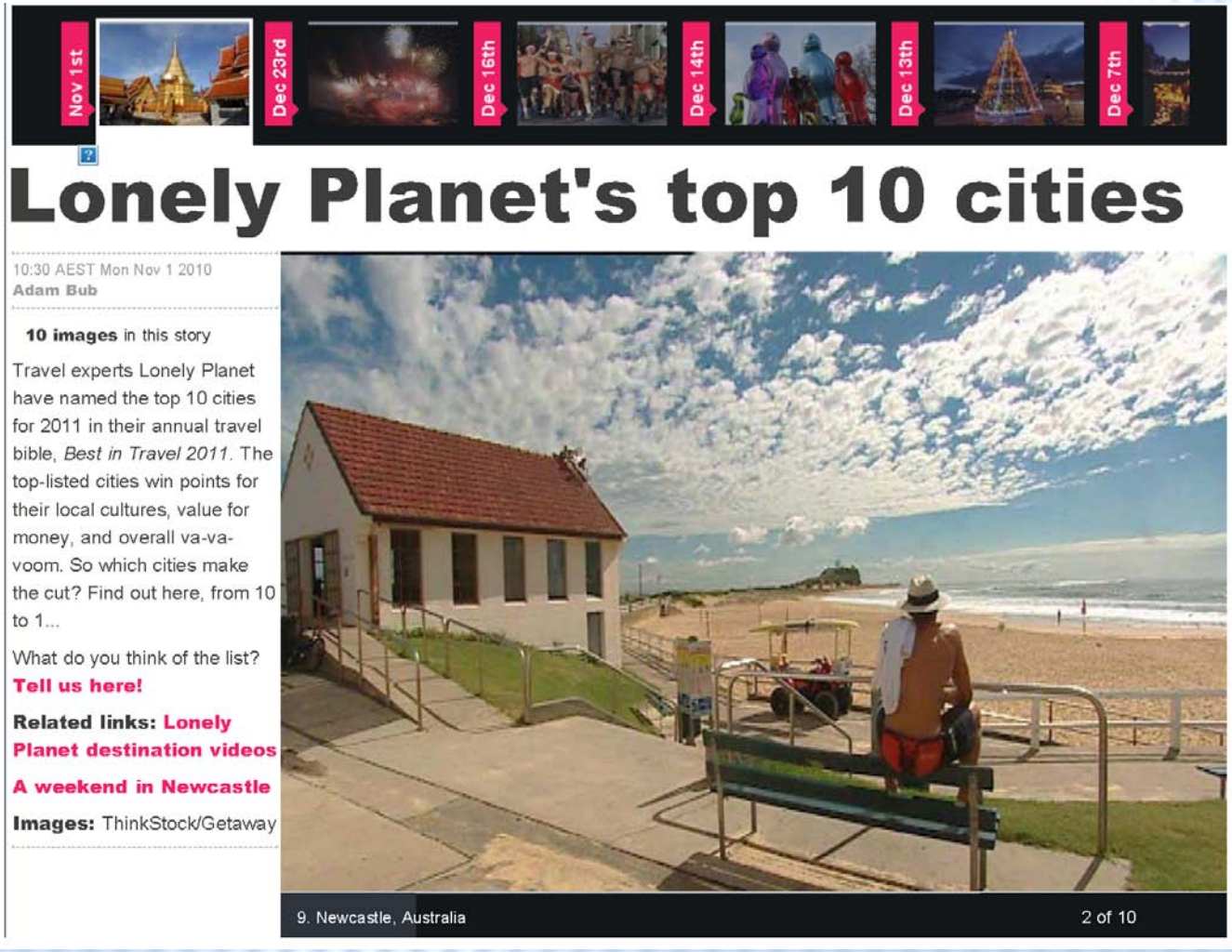
AMSI
AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

CARMA

Colloquium, November 3, 2011

Actually: Teaching and Researching with Collaboration Tools and Technology



National eResearch Collaboration Tools and Resources Project

Proposed NeCTAR VLs

Effective Teaching
Effective Learning
in the Quantitative Disciplines

Six VL nodes in:

Applied Statistics

Dynamical Systems

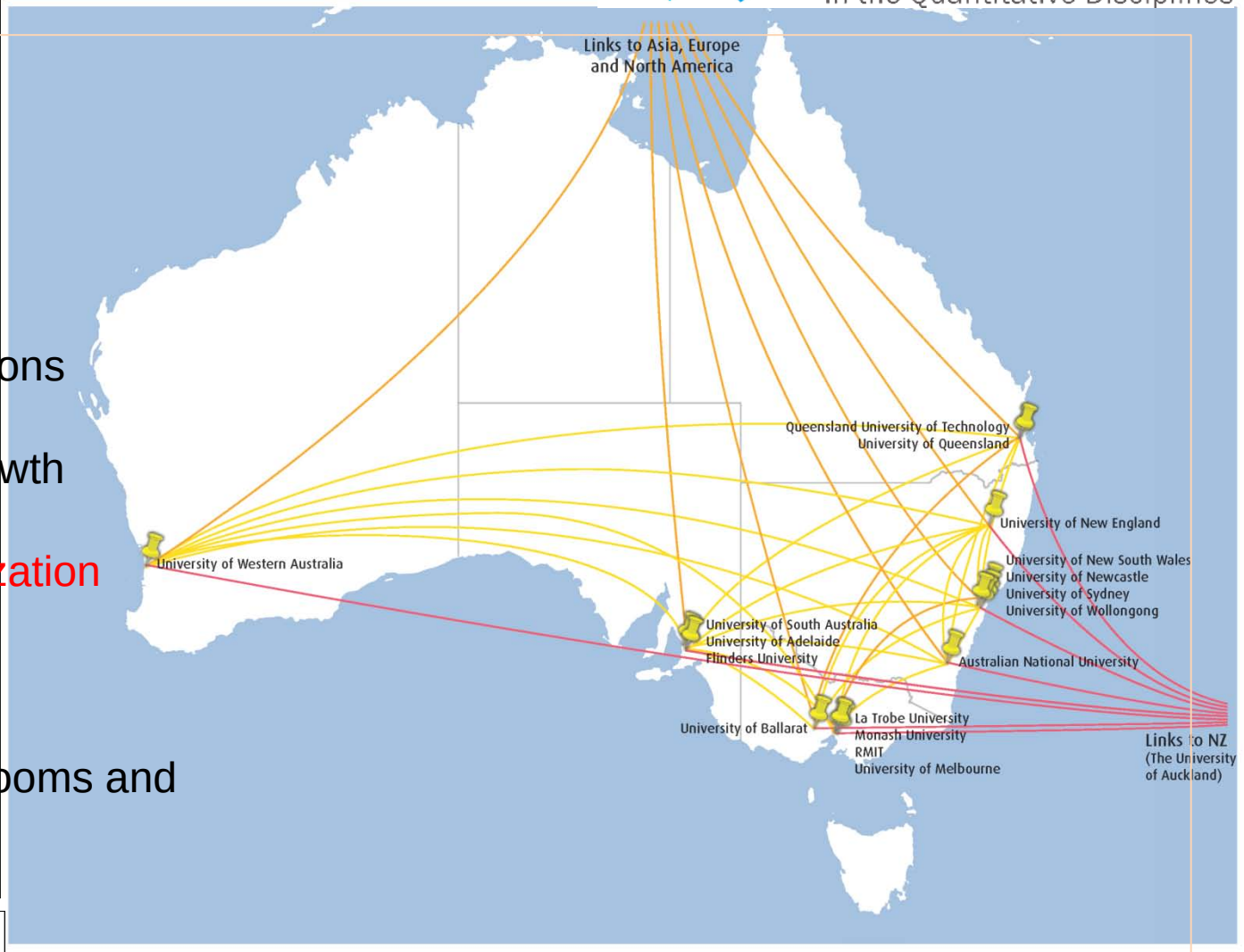
Geometry & Applications

Modelling Tissue Growth

Mathematical Optimization

Symmetry

based on AMSI AGRooms and



ANZIAM Special Interest Group in Mathematical Optimisation

Next Generation eResearch Collaboration in the Mathematical Sciences

Effective Teaching, Effective Learning in the Quantitative Disciplines

funded by Australian Learning and Teaching Council

Teaching with Collaboration Tools at the Tertiary Level?

Effective Teaching
Effective Learning
in the Quantitative Disciplines

Support provided by ALTC, an initiative of the Australian Government Department of Education, Employment and Workplace Relations. The views expressed in this presentation do not necessarily reflect the views of the Australian Learning and Teaching Council Ltd.

Jonathan Borwein FRSC, FAA, FAAAS
CARMA, University of Newcastle
Computer **A**ssisted **R**esearch **M**athematics and its **A**pplications

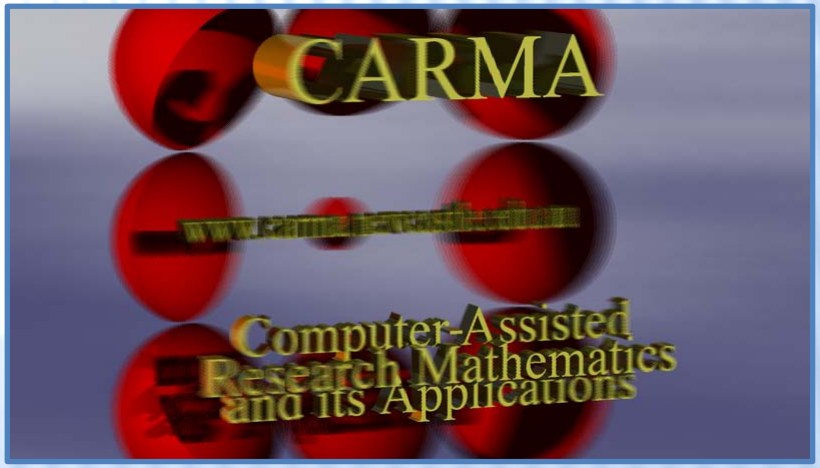
Effective Teaching
Effective Learning
in the Quantitative Disciplines

Actually: Teaching and Researching with Collaboration Tools and Technology.

I shall describe highlights of my two decades of experience with **Advanced Collaborative Environments** (ACEs) in Canada and Australia, running shared seminars, conferences, resources and courses over the internet.

Presence at a distance

- What works
- What doesn't?
- Why?



CARMA's 3D Logo

Revised 28/09/11

Research, Teaching & Outreach

Effective Teaching
Effective Learning
in the Quantitative Disciplines

- Are each helped by the others - and by collaborative technology - but **content comes first**

Teaching is Hard

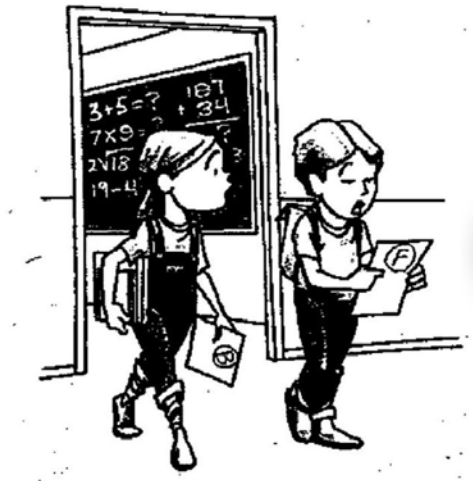
Effective Teaching
Effective Learning
in the Quantitative Disciplines

- Especially teaching easy things
- You can't take liberties

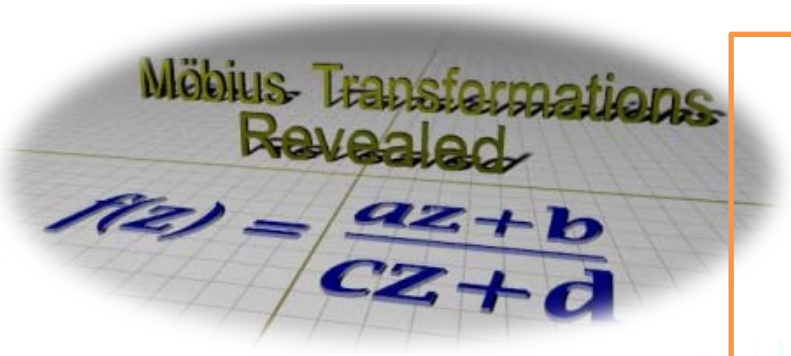
- Technology can help
- But only so much
- Unis can't afford much

Technology Includes

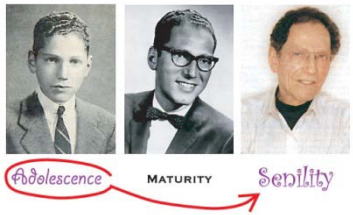
Effective Teaching
Effective Learning
in the Quantitative Disciplines

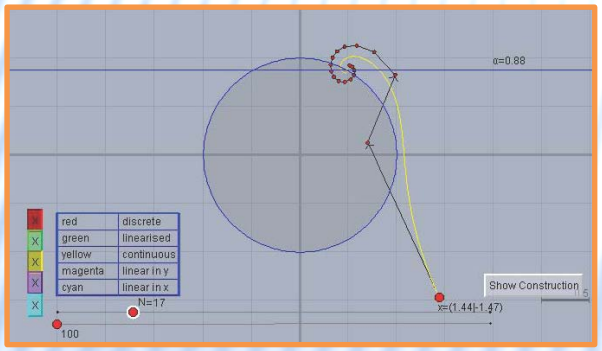


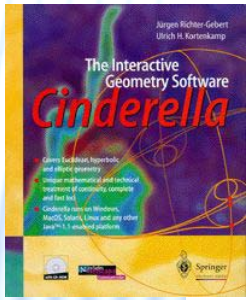
"It's not the math I hate...it's the *after*math."

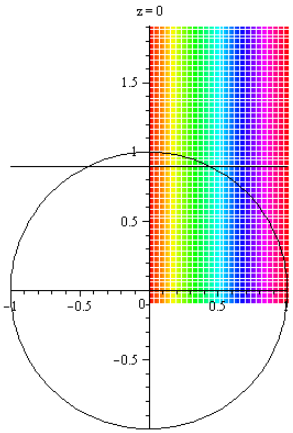


Tom Lehrer's
That's Mathematics









All Artefacts:

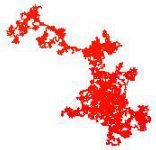
- Cartoons
- Pictures
- Films
- Music
- Animations
- Simulations
- Spreadsheets
- Packages
- Applets
- Haptics
- Virtual Reality
- Blogs (Math Drudge)
- JSTOR, Amazon, iTunes...

- http://www.carma.newcastle.edu.au/~jb616/lm-june.htm

Technology Includes

Effective Teaching
Effective Learning
in the Quantitative Disciplines

Random walks on the first million digits of Pi (top) and e (bottom)



That's Mathematics

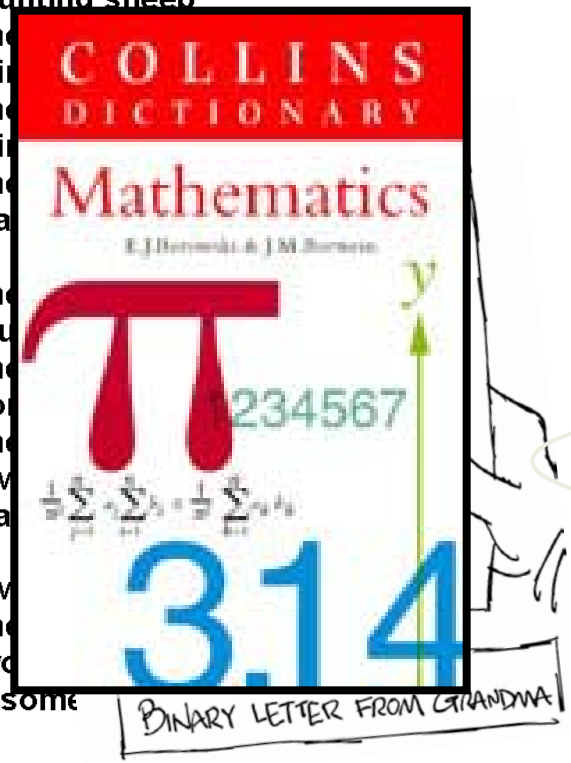
Tune - "That's Entertainment

This was most likely written for the July Fermat Fest held in San Francisco.

Counting sheep
Wh
Bei
Wh
Bei
Wh
Tha

Wh
Bou
Wh
Fro
Wh
Hov
Tha

Hov
Wh
If yo
Or some



When yo
How much postage to use,
When you know
What's the chance it will snow

July 16, 2002

Jonathan Borwein
CoLab, Dept. of Mathematics
Simon Fraser University
8888 University Drive
Burnaby, BC
Canada V5A1S6

Dear Jonathan Borwein:

As sole copyright owner of the song THAT'S MATHEMATICS, I grant you permission to use it on the CD mentioned in your letter of July 7th, in the manner described therein.

I dare say I should charge a fee for this use, but since I assume the song is already out there on the web in mp3 form without my permission (as many of them are), I can't justify penalizing you for being honest. In other words, there will be no charge.

I own all the rights, by the way, so you don't have to clear it with Rhino. If there is to be any printed material accompanying the CD, the credit should read: © 1995 Tom Lehrer. U

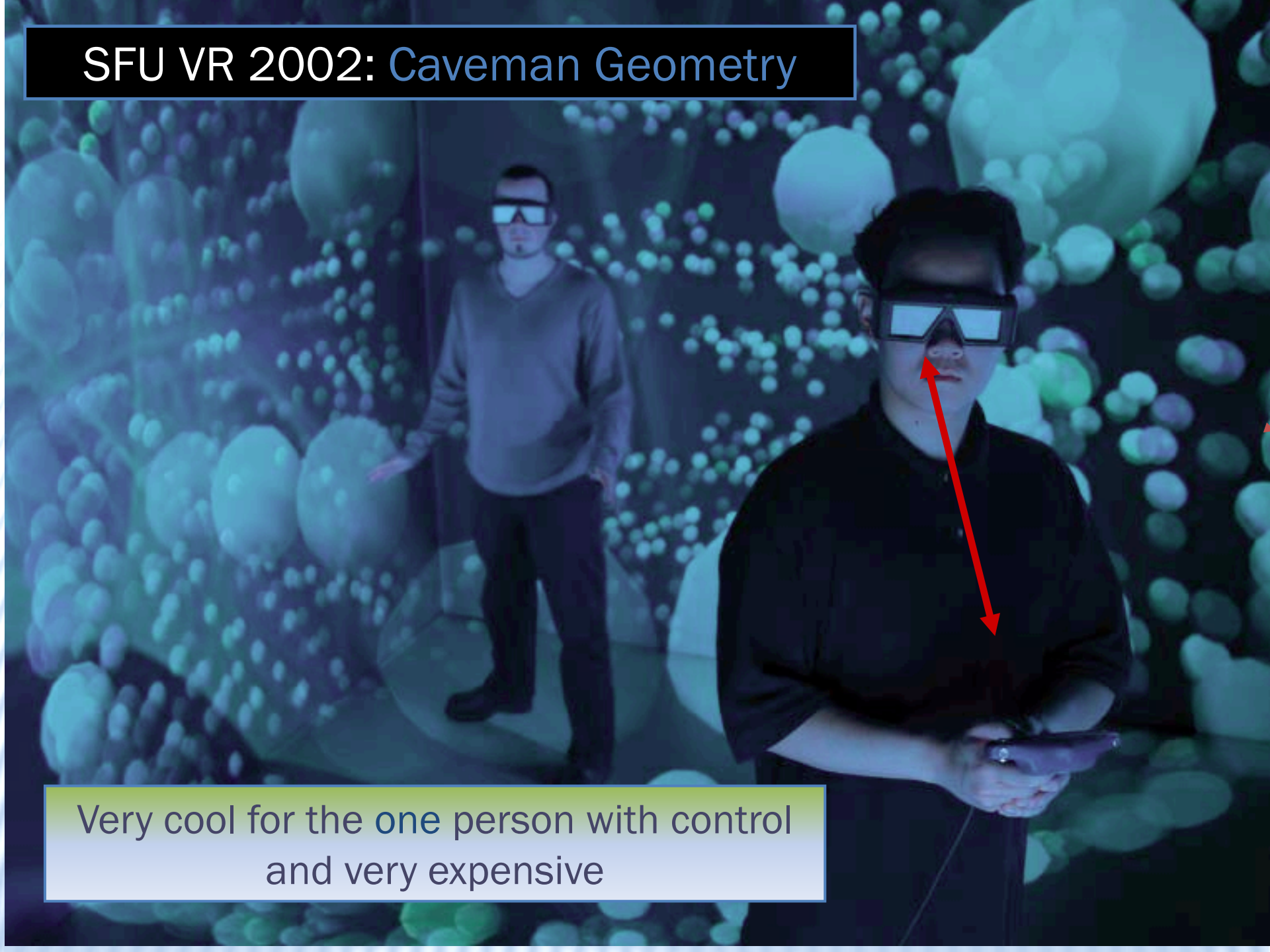
Good luck with your project. graduates who can't determine the remaind e decimal that appears on the calculator), I ation.

Sincerely yours,

Tom Lehrer

Geek Heaven!

SFU VR 2002: Caveman Geometry



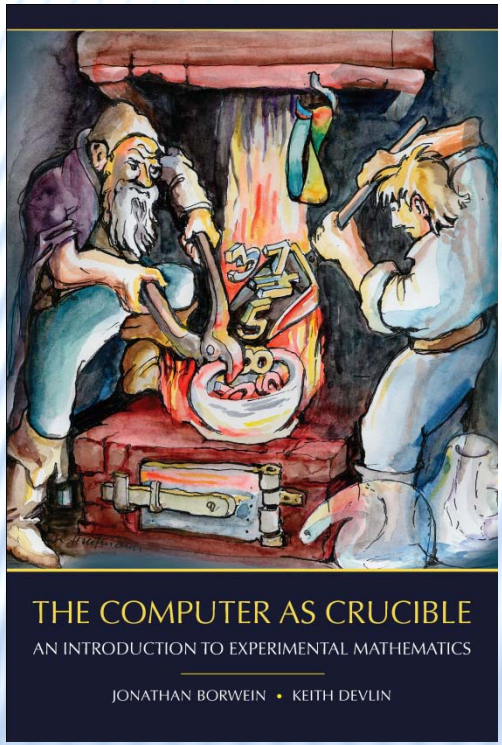
Very cool for the one person with control and very expensive

Resources not Courses?

Effective Teaching
Effective Learning
in the Quantitative Disciplines

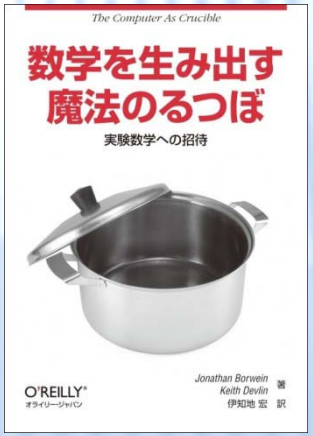
- Current and expected advances in mathematical computation and scientific visualization make it now possible to do(teach, learn) mathematics in many varied and flexible ways.

- We'll continue to explore and flag the opportunities to integrate computational, graphic and other tools into our teaching - for philosophic, pedagogic and aesthetic reasons



- http://www.experimentalmath.info
- http://carma.newcastle.edu.au/portal/
- 2008

2009



2010

"Seminars" on Hormones

Effective Teaching
Effective Learning
in the Quantitative Disciplines

- 1991-93 Internet based experience (pre WWW)
  - www. cecm.sfu.ca
- 1994-2001 PL in Canadian **NCE TeleLearning**
  - Multimodal Modal Mathematics (many early Applets)
  - 1994-6: Organic Mathematics Project (OMP)
  - AMS Notices article (in Press)

- 2001-03 www.irmacs.sfu.ca
  - Nationally funded math-science collaboration centre
  - 2002 SFU CoLab: my 1st ACE (session at ICIAM03)
  - 2006 Talk on ACE-Collaboration to SSHRC
  - 2003-2011 WestGrid ACE Research Project

WestGrid

2003

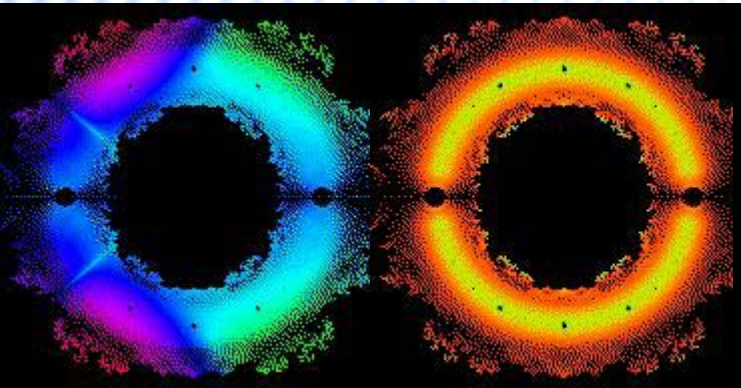

U of L PE 256
SFU - Colab
Pierre Boulanger
SFU - Colab
University of Alberta
The AG in Action
in CoLab
UBC - MAGIC
Netera AG
westgrid...

Pictures in Mathematics

Effective Teaching
Effective Learning
in the Quantitative Disciplines

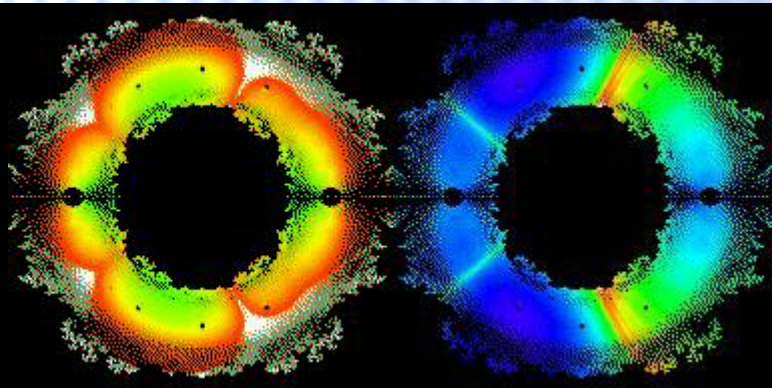
A heavy warning used to be given [by lecturers] that pictures are not rigorous; this has never had its bluff called and has permanently frightened its victims into playing for safety. Some pictures, of course, are not rigorous, but I should say most are (and I use them whenever possible myself). J. E. Littlewood, 1885-1977

From Littlewood's Miscellany (p. 35 in 1953 edition). Said long before the current graphic, visualization and geometric tools were available.



Roots of Zeros

What you draw is what you see (visible patterns in number theory)

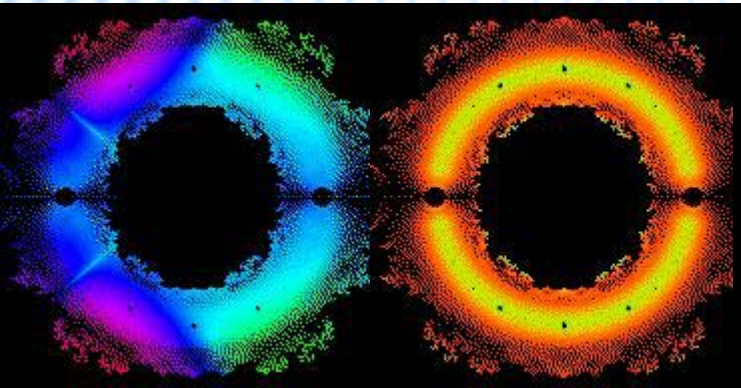


Visual Theorems

Effective Teaching
Effective Learning
in the Quantitative Disciplines

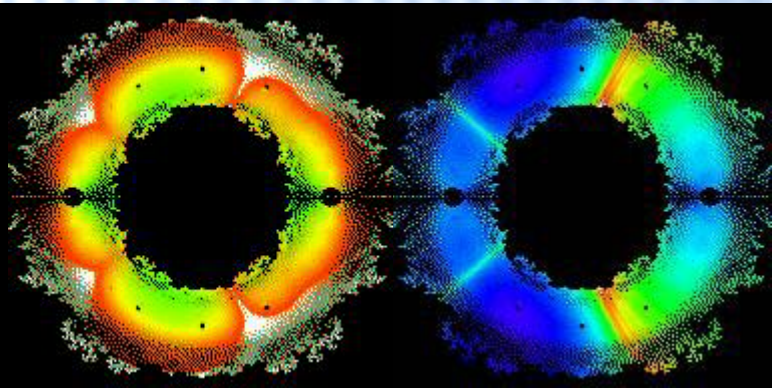
Briefly, a visual theorem is the graphical or visual output from a computer program - usually one of a family of such outputs - which the eye organizes into a coherent, identifiable whole and which is able to inspire mathematical questions of a traditional nature or which contributes in some way to our understanding or enrichment of some mathematical or real world situation.

Davis et al, The Mathematical Experience, 1993, p. 333.



Roots of Zeros

What you draw is what you see (visible patterns in number theory)



Pictures as Datasets

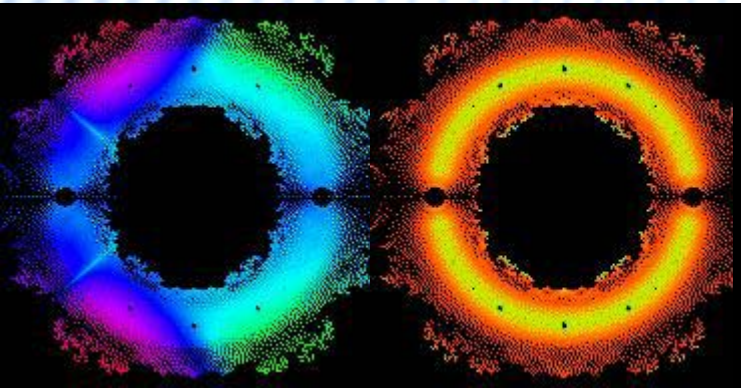
Effective Teaching
Effective Learning
in the Quantitative Disciplines

Striking fractal patterns formed by plotting complex zeros for all polynomials in powers of x with coefficients 1 and -1 to degree 18 (from Organic Maths)

Coloration is by sensitivity of polynomials to slight variation around the values of the zeros. The color scale represents a normalized sensitivity to the range of values; red is insensitive to violet which is strongly sensitive.

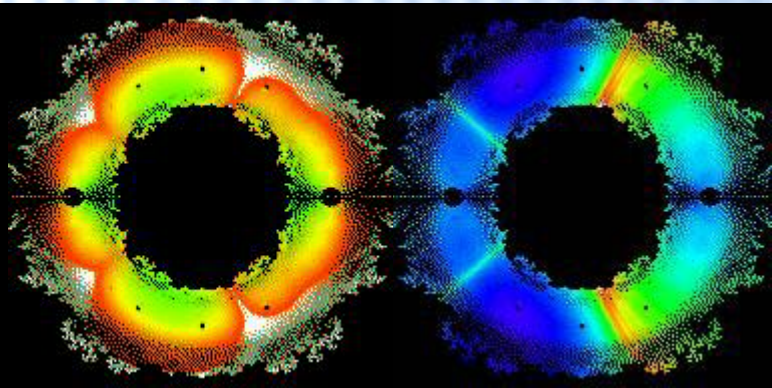
- All zeros are pictured (at 3600 dpi)
- Figure 1b is colored by their local density
- Figure 1d shows sensitivity relative to the x^9 term
- The white and orange striations are not understood

A wide variety of patterns and features become visible, leading researchers to totally unexpected mathematical results

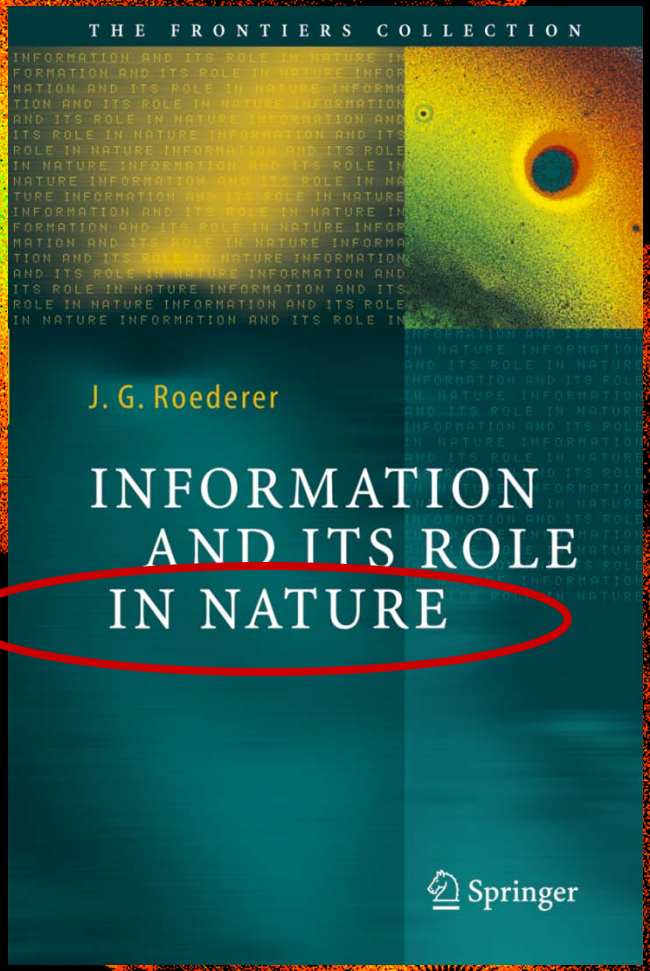


Roots of Zeros

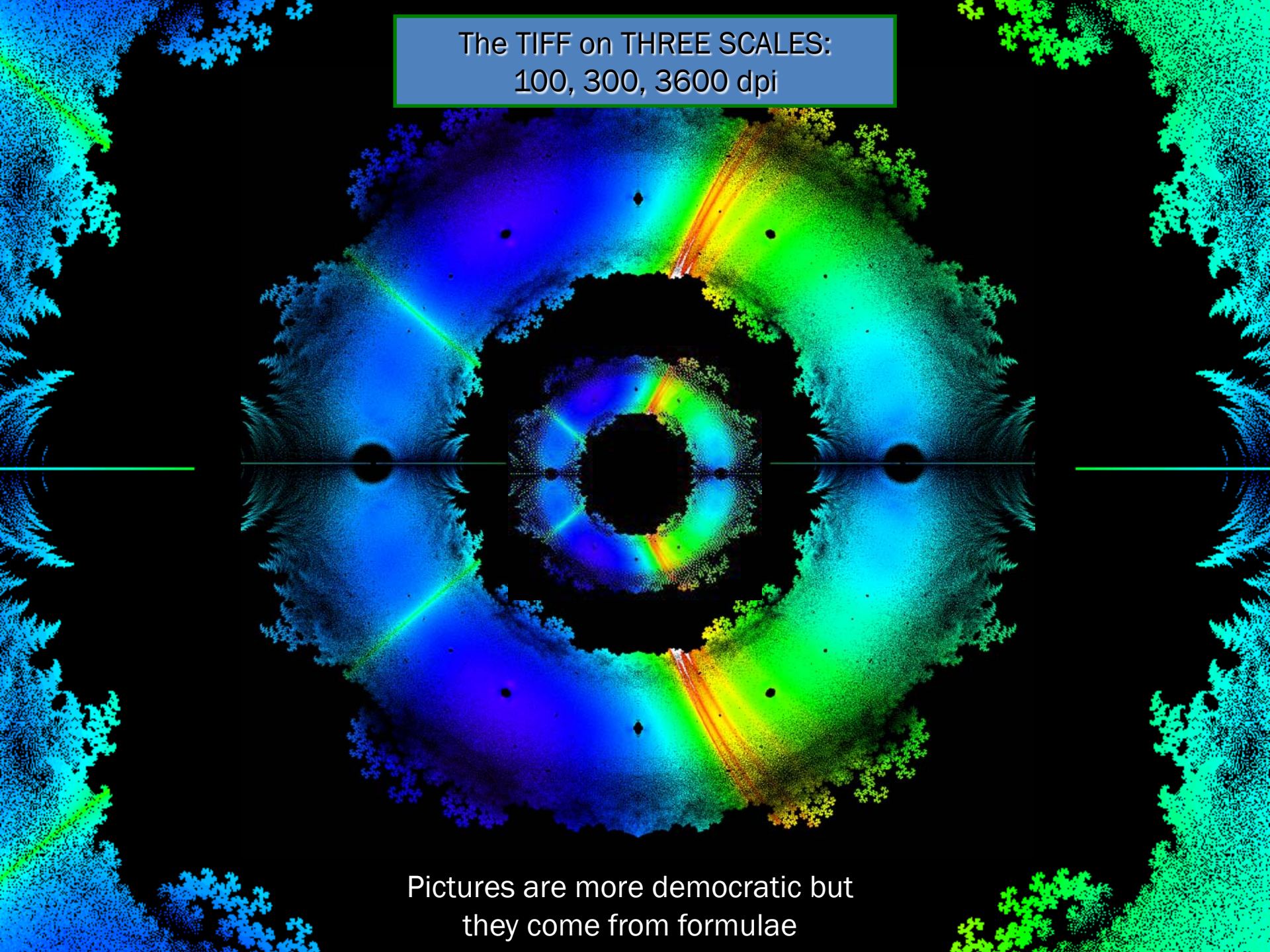
What you draw is what you see (visible patterns in number theory)



Roots in the most stable colouring



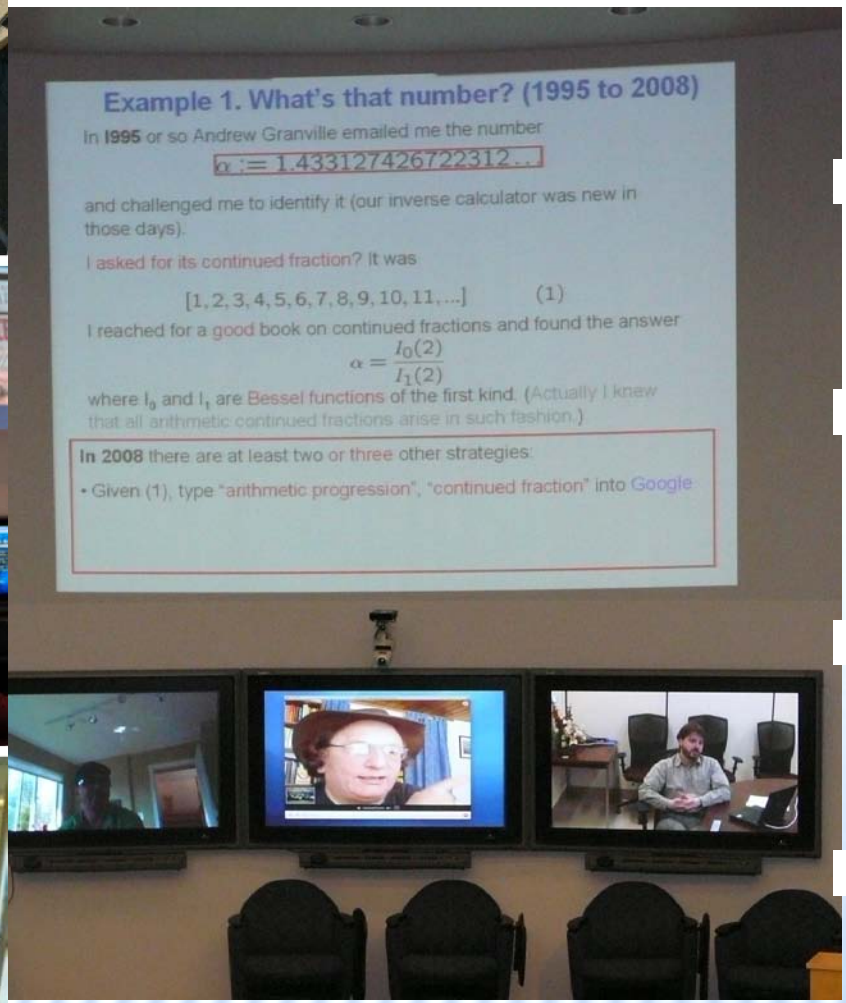
The TIFF on THREE SCALES: 100, 300, 3600 dpi



Pictures are more democratic but they come from formulae

Transcontinental Lectures

Effective Teaching
Effective Learning
in the Quantitative Disciplines



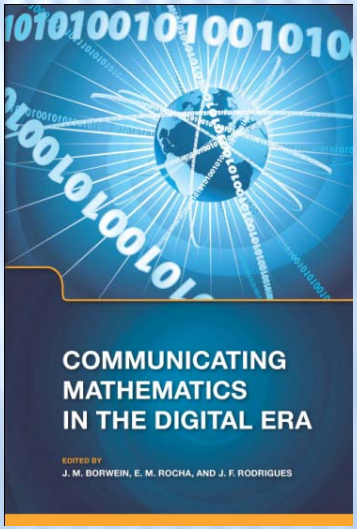
- L: PBB in Vancouver BC on **H323**
- C: Me in Newcastle NSW on **Skype** (both at home)
- R: Scott in Halifax NS on **Access Grid**
- Now microseconds matter

Main Audience in **IRMACS**
100 seat passive 3D room

Dislocated Conferences

Effective Teaching
Effective Learning
in the Quantitative Disciplines

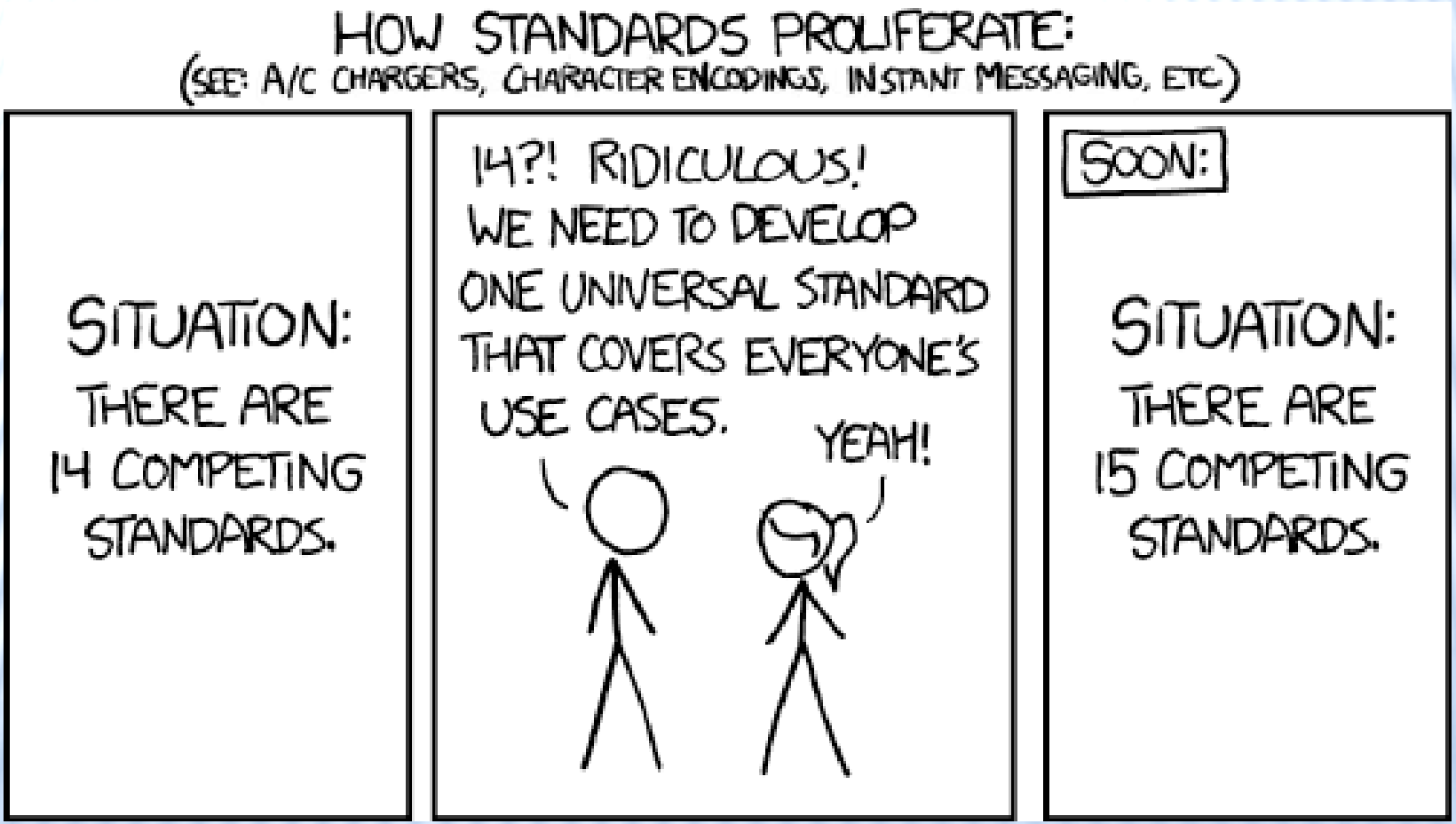
- 2001 Many distance Seminar & Conference Presentations: Skype, EVO, Access Grid, H323, …
  - 2009 IRMACS-Fields Number Theory: shared plenaries
  - 2011 JonFest 2011 in Vancouver: AG and streamed …
- 2005 Frequent dislocated Theses defences and Job Interviews (in many fields)
- 2005 The C2C (‘coast to coast’) seminar
  - 2008 Book chapter (on what and what not to do)
  - 2008 Presentation on C2C experience
  - 2011 6 years of Remote Collaboration article
- 2011 TransPacific Workshop regularly with UBC/SFU



Standards, Standards

Effective Teaching
Effective Learning
in the Quantitative Disciplines

- Uniformization only works up to a point
- Organizational and technical agility are critical



Technological Issues

Effective Teaching
Effective Learning
in the Quantitative Disciplines

- **Picking the right technology** for a given setting
  - Applications layers? Interactivity?
- **Multi-site** and **band-width** issues
  - Decide who is the client/server
  - Security issues: tests, interviews
- **Sound**
  - Echo cancellation/feed back
  - Questions/muting/microphones
- **Images**
  - Computer and/or cameras
- Avoid unnecessary bells and whistles

Technological adoption decisions are usually made by institutional ignoramuses who never have to, nor could, use the resources (from Blackboard to iPad)

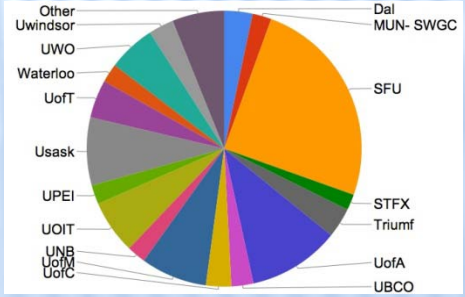
Organizational Issues

Effective Teaching
Effective Learning
in the Quantitative Disciplines

- Quality Assurance
  - Practice sessions are key
  - Rules to be followed
    - It should be 'easy as chalk' but …
  - Adequate human technical support

- Production events or one- off experiments?
  - Effort to reward ratio?
  - Advertise, Advertise.
    - Under promise and over deliver
  - Try to store, measure and get feedback

- An HCI class ppt analysis of a CoLab Honours class, and more



CoLab @SFU
Empowering Collaborations

My Maths Portal

Jon Borwein's Mathematics Portal

The following is a list of useful math tools. The distinction between categories is somewhat arbitrary.

Utilities (General)

1. The On-Line Encyclopedia of Integer Sequences
2. ISC2.0: The Inverse Symbolic Calculator
3. 3D Function Grapher
4. Julia and Mandelbrot Set Explorer
5. The KnotPlot Site
6. The Cinderella Geometry Site

Utilities (Special)

7. BBP Digit Database
8. Integer Relations Interface: PSLQ and LLL
9. EZ Face: Evaluation of Euler Sums and Multiple Zeta Values
10. GraPHedron: Automated and Computer Assisted Conjectures in Graph Theory
11. ProofWeb a system for teaching logic and for using proof assistants through the web
12. Embree-Trefethen-Wright Pseudospectra and Eigenproblems
13. Symbolic and Numeric Convex Analysis Tools

Reference

14. NIST Digital Library of Mathematical Functions
15. Experimental Mathematics Website
16. Numbers, Constants, and Computation
17. Numbers: the Competition
18. The Prime Pages
19. MathResource Online Dictionary

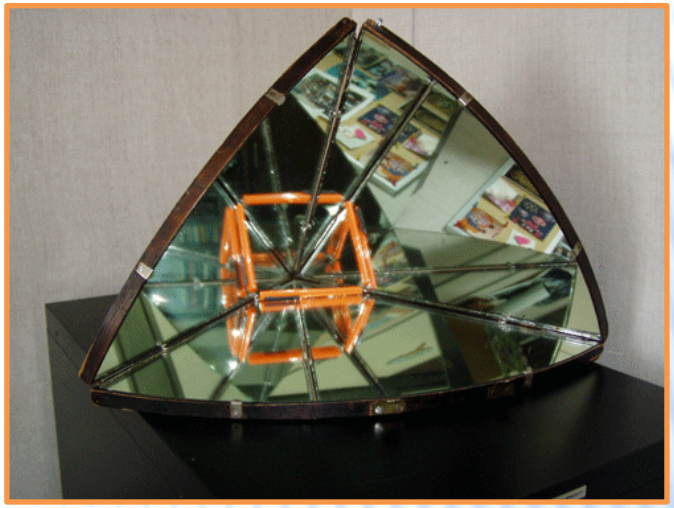
Content

20. Math in the Media (from the AMS)
21. Wolfram Mathworld
22. Planet Math
23. Wikipedia: Mathematics
24. Euclid in Java
25. Finch's Mathematical Constants

Math Courses 2011

26. MUlti Zeta Values Honours Course 2010 (Borwein and Zudilin)
    Given over the AMSI Access Grid Network

Effective Teaching
Effective Learning
in the Quantitative Disciplines



Coxeter 1930 CARMA 2010

Workshop

Effective Teaching
Effective Learning
in the Quantitative Disciplines

29 - 30 September, 2011
University of Wollongong, NSW

Presenters

- Leigh Wood, Macquarie University
- Caz Sandison, University of Wollongong
- Walter Bloom, Murdoch University
- Jonathan Borwein, University of Newcastle
- Christine Brown, University of Wollongong
- Paul Denny, University of Auckland
- David Easdown, The University of Sydney
- Mark Nelson, University of Wollongong
- Katherine Seaton, LaTrobe University
- Shane Wilson, ING Direct Australia

IRMACS Opening, 2005

Thank You