Dreams of a Mathematical Museum

We have heard much about the poetry of mathematics, but very little has been sung…

Henry David Thoreau

Mathematics in Australia is dying[1]. Enrolments in mathematics are declining[2]. Likewise our scores in international tests (e.g. TIMSS)[3]. University departments are shedding staff[4]. Some universities are closing their maths departments down completely. The previous federal govt poured millions into a regional maths centre to arrest this decline,[5] apparently to no effect. Commentators have spoken of something "snapping" in the culture[6]. Maths ignorance in the general community has reached stunning proportions. Contestants to a radio quiz had trouble answering what a billion was. As a result, the community becomes less and less logical and Post-Modernism rules triumphant.

Ask around and you'll find mathematics is usually the most hated school subject by a country mile, especially by school girls and women.

In response, most mathematicians (but not all) seem to just turn their backs to the cold winds of public indifference and retreat further into their bunkers.

The $64 question is WHY?

It shouldn't be like this. Mathematics itself is a great subject with a wealth of amazing pattern and surprises, a treasure trove of beauty and (yes) art, the closest thing we have to real magic. Yet that magic rarely, if ever, appears in classrooms or lecture theatres. Great mathematics is being done NOW that doesn't even rate a mention in the press. Instead we get the usual flood of "celebrity", manufactured political chatter, "art", and endless, ever-repeating sport – the great opium of the masses.

Nowhere is the richness and infinite scope of mathematics celebrated.

Consider, for instance, the way mathematics is ignored compared to art.

With art, everywhere you see galleries, workshops, lessons and classes, newspaper and magazine articles, regular weekly media sections, radio and TV programs. There are numerous art councils, committees, festivals, exchanges, usually pumping out "the same old, same old".

And mathematics?

Where are its works celebrated? Where do people go to see its greatest achievements? Where do 10-year olds go to be inspired? Where is mathematical mecca? There isn't even an amateur mathematics network in this country unlike the USA, Europe and other countries.

Mathematics has been likened to art, but nowhere does it receive the same treatment.

To start to reverse this unjustified invisibility may I recommend a centre for the general public to visit and experience the best of what mathematics has discovered. That is a **Mathematics Museum**. No lectures (apart from guest ones), no exams, no assignments. Just inspiration, a showcase of its best.

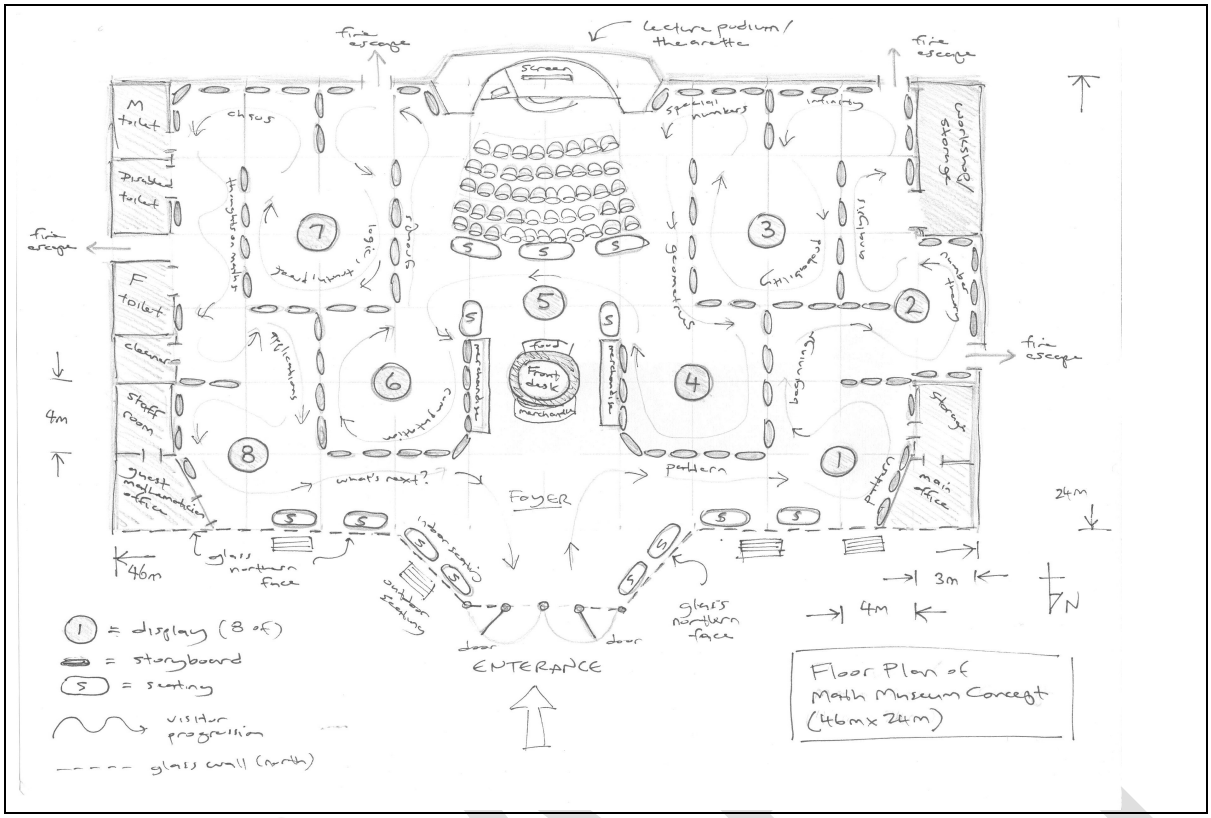
An internet search shows that there are very few such museums in the world. And most of them look a bit "mickey mouse". There are plenty of museums of zoology, anthropology, science, natural history, geology, archaeology, even of police, Jewish history and democracy! We have botanical gardens, writer's centres (7 in NSW), theatres, and sporting complexes. There was even an education centre on voting by the AEC in Melbourne (20,000 visitors per year until the 2008 Fed budget closed it down). But, in this country, nothing for mathematics.[7]

Such a museum could take many forms from austere low-cost to expensive grandiose architectural statement.

To steer away from these extremes, I'll paint a vision of a supermarket-sized space that will allow 2-3 hours to stroll around and (hopefully) be knocked out by.

There would be numerous displays, audio-visuals, storyboards, hands-on activity centres, a theatrette/podium and room for a in-house mathematician and some mathematical art.

Below is a very rudimentary freehand sketch of a floor plan for a 46m by 24m museum.



In this preliminary proposal there would be about 130 2m by 2m panels (storyboards) some with flat screens (about 40 of).

Below is a preliminary outline of content:

A Possible Thematic Scheme

Theme	items/objectives	mini-biographies on:
1. What is Mathematics?	Portray its spirit, scope and connectedness. Give overview, introduce later themes. Pose questions: Is the Solar System stable? How do computers play chess? What is randomness? How many shuffles do you need to mix a deck of cards? Is space inifinte? Could a super large computer solve all mathematical problems? How long is the coast of Tasmania? How accurate are polls? Are month long weather predictions possible? How many twists do you need to unscramble a Rubik's cube? Does a new temperature	Ramanujan

	record imply climate change? How are statistics used to lie? Objective: whet appetites	
2. Pattern	• In space (tessellations, platonic solids) • With numbers (fibonacci numbers, diophantine equations,Kaprekar's process, etc) • In nature (self-similarity, Mandelbrot set)	Marjorie Rice Erdos
3. Numbers	• Early history (Sumerians, Greeks, Pythagorean mythlogy, Romans, Hindu, Middle East) • Natural numbers (primes, congruences,,etc) • Real numbers (pi,e,phi, Bernoulli numbers) • Others types of artihmetic (Russian multiplication, shortcuts, etc) • Other number systems (algebraic numbers, complex, vectors, etc)	Fermat
4. Geometries	• Euclidean • Non-Euclidean (esp: Riemann) • Projective • Multidimensional • Topology (map colouring, mobius strip, Mordell's 1922 conjecture) • Fractal dimensions (Hausdorff, Sierpinksi, Koch curve) • Noncommutative geometries	Riemann

5. Chance	• Gambling, polls • Common mistakes (gambler's fallacy, cancer clusters) • Bell Curve (Central Limit Theorem, etc) • Stochastic Systems (random walks, markov chains) • Poisson Processes (customer arrivals, passing cars, static on telephones) • Paradoxes (Simpson's, Parrando's, etc) • What is randomness? (psuedo-random number generators, Noise (white, 1/f), entropy)	Kologormov
6. Groups	• Solvability of equations • 17 2D and 230 3D symmetry groups • Classification of finite simple groups (26 sporadics) • 5-fold semi-symmetry, quasicrystals and non-periodic tiles • Rubik's cube • Orthogonal Latin Squares	Galois
7. Analysis	• Zeno's paradoxes and Archimedes, Hindu and Middle East anticipations • Let there be Newton! (and Liebniz) • Modelling the Universe (predicted discovery of Neptune, etc) • Euler,Gauss, Jacobi, Hardy-Ramanujan • 3 body problem (recent wild non-standard orbits – horseshoes, figure 8's, etc) • Principle of Least Action, fixed	Euler

	point theorems • Complex plane, conformal mapping, etc • Reimann's zeta function and hypothesis • Fourier series, Wavelet theory • PDEs (wave equation, Navier-Stokes equation) • Hilbert Space and Quantum Mechanics • Multiplicative calculi	
8. Chaos	• Turbulence: Lucretian physics, the clinamen and Laplace's God • Intimations by Poincare, May • Lorenz (strange attractors) • Feigenbaum (cascading bifurcations) • Mandelbrot (fractals) • KAM theory (Is the Solar Syastem stable?)	May Mandelbrot Feigenbaum
9. Infinity	• Problems of: Aristotle, Galileo • Cantor's paradise • Continuum Hypothesis (Cantor, Cohen) • Surreal numbers	Cantor Conway
10. Mathematics and Art	• Middle Eastern tilings, Penrose tiles • Escher • Golden mean • Perspective • Computer simulation of shading/reflection • Mathematical sculpture • Fractal mountains, leaves, etc	Tim Lehrer

	(special effects) • Maths in Movies (Jurassic Park, A Beautiful Mind, Good Will Hunting)	
11. Logic	• Axiomatic systems (Euclid's postulates, Peano, etc) • Boolean algebra • False proofs within Euclidean geometry • Set theory • Russell, Hilbert's program • Fasle dreams of consistency/completeness (Godel, Turing) • Unprovable propositions • Axiom of choice plus Banach-Tarski paradox • Formalism, Logicism, Intuitionism	Hilbert
12. Computation	• Early computers (slide rules,Babbage's Analytical Engine, valve computers, Enigma decoder) • Calculator tricks (and errors (truncation, etc)) • Turing machines, decision problems (busy beaver, the word problem, Turing test) • Case study: Hilbert's 10th problem • Enumerable sets and Diophantine equations • Cellular automata (game of life) • Chess programs (min-max theorem) • Game theory (prisoner's dilemma, tit-for-tat) • Hard problems (travelling salesman, hamiltonian circuits,	Turing Von Neumann Davis/Putnam/Robinson

	factoring) • Randomness of Arithmetic (Chaitin) • Demos of mathematical software • Computer discoveries and assisted proofs (4 color problem, Feigenbaum conjectures, BBP algorithm, 111 order latin squares, counterexamples (Merten's conjecture))	
13. Applications	• CAT scans and Radon Transforms • "Interplanetary Highway" (low energy transfers) • Communications (public key cryptography, error-correcting codes, concept of entropy, Information theory (Shannon)) • Biomathematics (gene sequencing, evolutionary trees, ecosystem simulation,etc) • Business (decision theory, queueing theory, optimization, logistics, etc) • Simulations/Modelling (airflows, ecosystems, galaxies, climate (Courant's condition, Lewis Richardson), bushfires, epidemics)	Lewis Richardson
14. The Future	• Unsolved Problems (twin primes, Goldbach's conjecture, Riemann's Hypothesis, 3x+1 problem, etc) • Exploratory maths (computer exploration and discovery) • Lack of women mathematicians (not a feminist rant). Need for more mathematicians, public awareness and appreciation • Areas deserving attention	Borwein brothers Tao

	• Quantum computing • The Unreasonable Effectiveness of Mathematics • In Praise of Amateurs (Fermat, Ramanujan, Margorie Rice, Mandelbrot, Wikipedia) • Modus Operandi (mathematicians telling how they work)	
15. Resources	• Contacts/material • Merchandise (books, clothes, puzzles, software,CDs, DVDs, calculators, computers) • In-house mathematician • Thank you to sponsors, comments book	

All sprinkled with anecdoteson and quotes by Erdos ("A mathematician is a machine for converting coffee into theorems"), Hardy (mathematics as a distant mountain range), Hilbert ("We must know, we shall know"), Pascal (heart vs mind), Newton (boy on seashore), Weierstrass (poetry of maths), Ramaujan (1729) , Einstein (Euclid's Holy book) and so on.

Traditional educators are likely to say "This is far too advanced for the general public". And that is true. But we should not being expecting any large degree of understanding. The intent will be to present a panaroma of mathematics alone, nothing more. We just want to "blow" the occassional mind and make it think: "I don't fully understand much of this … but I want to find out more". That's it. You don't hook people into art by starting with the microscopic properties of paint – you take them to a gallery. Likewise mathematics. Only it doesn't have a gallery … yet.

Under **NO** circumstances should the "educators" turn the museum into a glorified classroom, and thereby continue to turn people **OFF** mathematics. This problem is not new:

"…mathematics has the dubious honor of being the least popular subject in the cirriculum… Future teachers pass through the elementary schools learning to detest mathematics … They return to the elementary school to teach a new generation to detest it."

Polya (1956) citing a recent study

You **CANNOT** teach people anything in a brief 3 hour (or less) visit. The sole purpose will be to **showcase** and (hopefully) **inspire**. If **inspired**, people will be more likely to endure the difficulties exploring mathematics presents. If "taught at", they will just switch off as per school.

A realistic (?) objective would be to help:

1 in 20 visitors lose their maths-phobia
1 in 50 develop some maths appreciation
1 in 100 develop a lifelong interest in maths
1 in 1,000 become serious mathematicians
1 in 100,000 become high-level research mathematicians
1 in 1 million are inspired to reach Ramanujan class or better

That might be a decent outcome.

The objective should be to turn as many of these

(Andrew Wiles at 10, the age he first heard of Fermat's Last Theorem from a library book)

into as many of these

and all grades in-between.

Interest in books of mathematics (like Simon Singh's bestseller "Fermat's Last Theorem" and Glieck's "Chaos"), the popularity of Rubik's Cube, the way kids take to computers show there is an innate interest in mathematics by the geenral community which is not served by curent institutions. There is a desperate need to take mathematical exposition from the 19th century (rote learning, classroom drones, marking for life of more than 50% of students) into the 21th century. A maths museum might be part of a movement away from "business-as-usual". Without a amateur community unrestricted by the "gatekeepers" who routinely destroy the subject, attempts to increase interest in and appreciation of mathematics is sure to be short-lived in effect. That would be a terrible shame.

References:

1. *A National Strategy for Mathematical Sciences in Australia* (3 March 2009) Prof. Hyam Rubinstein (www.amsi.org.au)
2. Number of Year 12 students doing 'Advanced' Maths declined 20% (25,000 to 20,000) from 1995 to 2007
3. US and English students recently began to outperform Australian students in TIMSS tests (www.acer.edu.au/timss/)
4. Article *"Australian Maths No Longer Counts"* Peter Hill p43 Australian Science July 2004

   "The number of mathematical scientists in Australian universities is today about 65% of what it was in the mid-1990s" (quote)
5. The UNE Regional Maths Centre ($4.95 million initial grant)
6. Article *"Go Figure"* The Bulletin 15 Oct 2004 p20
7. Rio Tinto already sponsor Scitech's "Maths Factory Roadshow" in WA (see www.scitech.org.au) which shows sponsoring by business isn't impossible. Questacon (Canberra, ACT) did have a mathematics exhibit which, judging from material from the web, is mercifully dead.

Appendix: Some very crude economics

Income:

Target admissions would be about 60,000 per year (about 200 per day consisting of about 120 students and about 80 adults/tourists) for a 6 day week (Mon – Sat , 10am – 4pm). With admission of $5 per student and $7 per adult that would give income of about $350,000 per year. Add shop profits of $1 average per attendee and corporate sponsorship of $50,000 per year(or better?) and total income would be about $460,000 per year.

Costs:

Costs (very approximate) would provide for :

5 staff

(1 manager/accounts ($60K/yr), 1 admissions/shop assistant ($40K/yr), 1 guide/security/handyperson ($40K/yr), 1 in-house mathematician ($40K/yr), 1 P/T contract cleaner ($20K/yr))

plus **casual relief workers** (holidays, sickness, maternity, etc) ($40K/yr)

and **trainee teachers/work experience** ($10K/yr for assoicated costs and expenses)

and **2-3 volunteers** ($10K/yr)

for a total of about $260,000/yr

add **operating costs and taxes** ($200,000/yr?) gives about $460,000/yr


(Ramanujan's home)

Location (for Australia) could be anywhere at first glance. But I would like to promote a centrally placed regional centre close to a rich transport hub to try to counter the disproportionately poor record in regional/rural areas. This would also allow a greenfields site with room for onsite accomodation (to keep wages low). I'd suggest either **Gunnedah** or **Dubbo.**

Construction estimates (very approximate):

Building (to lock-up stage, regional greenfields site): $2M

Onsite housing (block of 4 rooms/bedsits for trainees/work experience)$300K plus 2 apartments/houses ($400K): $700K

Grounds: $200K

Fitout: $1M

Museum design: $0.5M

Content creation (see below): $1M

Total (with 1st year wages, operating costs thrown in): say $6M

(This compares with $19.6M for QUESTACON and assumes donation of land and waiving of fees by local and state govt)

Content creation (films, video , artwork)

1. 10 physical exhibits at average $20K each: $200K

2. 130 storyboards (40 with video flat screens):

    a) Flat screens (40): $40K

    b) Research/development/mockups/design ($1K per panel): $130K

    c) Artwork/materials/construction ($2K per panel): $260K

    d) Video production ($4K per screen): $160K

    Plus 20% contingency gives ….

    Total (approximately): about $1M

Corporate sponsorship:

There are plenty of businesses in Australia with some sort of mathematical expertise that could contribute with both money and in-kind assistance. Possible examples include:

Computer: Google Australia, Yahoo Australia, Computerserve, eBay, Microsoft, Casio, Maple Soft, Wolfram Research, IBM, ACER, Toshiba, Intel

Resources: BHP Billiton, Bluescope Steel, OneSteel, Rio Tinto, Aloca, China Steel, Newcrest, CBH Resources, Coal & Allied, Centennial, ERA

Aviation: Qantas, Virgin, other airlines, BAe, Boeing, Airbus

Auto: Toyota, Honda, Better Places, GM

Communications: Telstra, Optus, Sing Tel, Nokia

Retail: Woolworths, Coles, IKEA

Finance: ANZ, NAB, Westpac, Coomonwealth, BT Investment, QBE, Sun Metway, IAG, Perpetual, AMP, Macquarie Group, etc

Gambling: Tabcorp, Centrebet, Tatts, Aristocrat Leisure

Energy: Origin, AGL, BP, Caltex, Woodside, Santos

Health: Cochlear, Merck, GSK, Johnston & Johnston

Chemical: Orica, Unilever, Proctor and Morris

Construction/real estate:John Holland, Leighton Holdings, Mirvac, Lend Lease, Grollo Constructions, Worley-Parsons, Westfield

Engineering: SKM

All comments welcome:

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