STEM Society Meeting, March 13, 2012

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Contents

1 **About the STEM Society and the STEM Society Website** 2

2 **The March Meeting Announcement** 3

3 **The T-FLEX Parametric Modeler** 3

4 **Video and Pictures of Charlie Mentesana's Piezo Moter Experiments** 4

5 **Scientific and Mathematical Writing: LaTeX** 4

6 **Bob Kessler: Book Review** *Turing's Cathedral: The Origins of the Digital Universe by George Dyson* 4

7 **Book Review: The Four Laws That Drive the Universe, by Peter Adkins** 7

8 **A Calculus Problem** 7

9 **How to Draw a Tribar** 8

10 **Statistics: Regression Analysis** 8

11 **David Frazee: Proposed Methods for Liquifying Gases** 9

12 **What is Algebraic Topology?** 9

13 What is Algebraic Geometry? **9**

14 What is a Differential Manifold? **9**

15 What is M-Theory? **10**

1 About the STEM Society and the STEM Society Website

STEM is an abbreviation for Science, Technology, Engineering and Mathematics. There are about 60 people on the mailing list, although usually a much smaller group attends any one meeting. We meet on the second Tuesday of each month at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The meetings are open to all. The start time is 6PM. We make presentations, have discussions, and sometimes have scientific demonstrations. The topics range from General Relativity to scientific experiments for kids.

The set of meeting notes may be viewed by going down the list of notes appearing on the front page of the site. These notes contains links to documents, which may be viewed or downloaded by clicking the link. Other documents can be reached by clicking the heading "Documents and Downloads" that appears on the left side of the front page. Then click on "documents." The meeting notes may also be viewed in an archive file in the list of documents. Most of the documents are PDF files. They may be viewed or downloaded to the computer by clicking, provided Adobe Reader is present, or another program capable of reading PDF files. There are often more documents available at the site than are listed under "Documents" because they may not have been added to the documents.htm file yet.

The web site is:

`http://www.stem2.org/`

Direct to the documents list:

`http://www.stem2.org/je/documents.htm`

Direct to the archive file:

`http://www.stem2.org/je/archive.pdf`

2 The March Meeting Announcement

The March meeting of the STEM Society will take place on the second Tuesday of the month, March 13, 2012, at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The starting time is 6PM.

Topics might be selected from the following list: Driving piezoelectric motors with microcontrollers such as the Arduino, Astronomy calculations, Using the Latex typesetting language, The four laws of Thermodynamics, Various Electronics projects and Biology projects, Drawing a Penrose Tribar. A little Algebraic Geometry, a review of some Calculus in connection with using Latex, a discussion of Regression Analysis, and a little electromagnetic theory. And of course any topic members want to introduce.

There are a few additions to the previous announcement. (1) I received an email from Dave Theilen about an interesting geometric modeler called T-FLEX. There is a free student version. It would be nice if he could give us some information about his experience with this.

(2) If you bring a laptop or a flash drive, we can distribute some software.

(3) Kessler will discuss the book: Turing's Cathedral.

3 The T-FLEX Parametric Modeler

Email from Dave Theilen to Jim Emery:

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Do you have any interest in parametric CAD software.
I ran across a product called T-FLEX.
It uses parasolids as the core.  Seems to come from Moscow.

I downloaded the free student version yesterday and am
trying to build a simple model.  It seems even
the student version does some FEM and dynamics analysis.
I haven't found the price of the full package.

I am considering applying for an academic license using
STEM as an excuse, with the group's permission of course.
I think students could get some good experience with
something like this.  Maybe model their robot and
show dynamics.
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Do you have a good free parametric CAD software package
that you like?
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4 Video and Pictures of Charlie Mentesana's Piezo Moter Experiments

I showed Charlie's video and pictures. He was not at the meeting, but will probably make a presentation next month.

5 Scientific and Mathematical Writing: LaTeX

If people would learn how to create mathematical and scientific documents with LaTeX, we might have an expanded group of authors presenting material at our STEM Society meetings.

Installing Miktex and a LaTeX Tutorial:

`http://www.stem2.org/je/miktex.pdf`
`http://www.stem2.org/je/GSWLaTeX.pdf`

6 Bob Kessler: Book Review *Turing's Cathedral: The Origins of the Digital Universe by George Dyson*

I don't have a record of Bob's presentation and the ensuing discussion, but here is another published review.

Review by Evgeny Morozov The Guardian The Observer, Saturday 24 March 2012

"The foundation myth of the internet invariably involves an iconoclastic and romantic technology entrepreneur, who, free from government restraint, enlists free-floating venture capitalists in building the Next Great Thing. It's a myth that borders on delusion, for some of the key technologies that led to the internet were underwritten by government subsidies and arose in the context of larger-than-life geopolitical battles.

Thus, cryptography, which powers much of today's electronic commerce, advanced in the background of the second world war, while packet switching a cold war-era technology that made the internet possible was to guarantee resilient communications in the event of a nuclear attack. More recently, 9/11 and the wars it unleashed have magically transported biometric technologies such as automated facial recognition from the battlefields of Afghanistan and Iraq into our offices and living rooms.

In Turing's Cathedral, George Dyson shows that the history of the modern computer belies the foundation myth as well. Dyson, who has previously written on the history of the Aleut kayak and a failed American attempt to send a mission to Mars, traces one particular effort to build and operate a computer the unassumingly named Electronic Computer Project (EPC) based at the Institute for Advanced Study (IAS) at Princeton.

EPC was underwritten by various parts of the American government shortly after the second world war. The idea was to use computers to forecast the consequences of a thermonuclear explosion; eventually, the IAS computer was also put to more peaceful uses in biology and meteorology.

The project's godfather the Hungarian migr John von Neumann was a polymath whose interest in computing had roots in both politics and academia. A superb mathematician who also made landmark contributions to economics and game theory, Von Neumann believed that computers might push mathematicians who constituted the most powerful group at the institute to appreciate the theoretical challenges posed by applied work. At the same time, his aversion to totalitarianism made him eager to help bolster the military might of his adopted homeland.

It took a genius of Von Neumann's scale to overcome the immense opposition to the project at the institute, which was a fascinating microcosm of intellectual life at the time (Dyson's book is worth reading for its treatment of the institute's early history alone). Building and operating a computer on the institute's premises meant opening its doors to engineers a development that professional mathematicians, averse as they were to any work that didn't require chalk, blackboard, paper and pencils, didn't like at all. The institute's humanists hated mathematicians and engineers alike and, now that the war was over, didn't shy away from expressing their discontent.

It didn't help that Einstein, who was then at the institute, opposed the idea of "secret war work" and feared that "the emphasis on such projects will further ideas of 'preventive' wars." However, "preventive wars" were exactly what the hawkish Von Neumann wanted: in the immediate aftermath of the second world war, he briefly advocated the idea of a quick preventive war with the USSR to be followed by a Pax Americana. He also had no qualms about working with the government, eventually leaving the institute in 1953 to join the United States Atomic Commission a government agency that would soon humiliate his friend and colleague Robert Oppenheimer by stripping him of his security clearance.

Strictly speaking, Von Neumann's was not the first computer. However, it played an extremely important role in getting the nascent computer industry off the ground. First of all, its origins in academia made it easier to get working scientists to pay close attention to what computing had to offer. Second, Von Neumann wanted to ensure that any work that the institute did on the EPC was put in the public domain and widely disseminated rather than patented by engineers (this noble effort was marred by Von Neumann's consulting gig with IBM not well-publicised at the time which required him to grant all of his own subsequent inventions to the company). T hird and most important Von Neumann chose not to optimise his computer to do only pressing or lucrative tasks; he knew that its most useful applications had not been anticipated yet. By arguing that "the projected device is so radically new that many of its uses will become clear only after it has been put into operation", Von Neumann helped to usher in the era of general-purpose computing which, alas, may now be finally coming to a close, as consumers embrace single-purpose apps and tightly controlled computing devices.

While Dyson doesn't shy away from discussing obscure technical and theoretical aspects of Von Neumann's computer, he also provides ample social and cultural context. Gottfried Leibniz, Francis Bacon, and Bishop Berkeley appear next to more contemporary luminaries such as Norbert Wiener (the originator of cybernetics), Vladimir Zworykin (a pioneer of television) as well as numerous members of the Huxley family (Aldous, Julian and Thomas). Dyson, who grew up at the institute, where his father Freeman Dyson was a fellow, also brings a charming personal touch to the narrative.

Alas, the book is not perfect. Dyson, who spent a decade writing and researching it, bombards the reader with a mind-boggling stream of distracting information that adds little to his tale. We get to learn of the discrepancy between the British and Canadian war records of Jens Fredrick Larson, the architect of the institute's main hall; the price of oysters served at lunch meetings of its building committee; the price of nappies in Los Alamos hospitals in the 1950s.

Dyson's efforts to connect Von Neumann's cold war computing to today's Silicon Valley result in a slew of untenable generalizations. Is it really true that "Facebook defines who we are, Amazon defines what we want, and Google defines what we think"? Occasionally, Dyson makes mystical claims that no serious historian would endorse. What to make of his statement that "only the collective intelligence of computers could save us from the destructive powers of the weapons they had allowed us to invent"? This is a very odd way to tell the story of numerous disarmament campaigns, of fervent antiwar activism of the 1960s, of the emergence of groups like Computer Professionals for Social Responsibility that sought to draw clear ethical boundaries between academia and the defence industry. Surely, all of that mattered more than the "collective intelligence of computers"?

Despite these shortcomings, Turing's Cathedral is an engrossing and well-researched book that recounts an important chapter in the convoluted history of 20th-century computing. An equally rich history of Google and Amazon is long overdue."

7 Book Review: The Four Laws That Drive the Universe, by Peter Adkins

`http://www.stem2.org/je/fourlaws.pdf`

8 A Calculus Problem

Prove that the derivative of

$$f(x) = \frac{1}{x}$$

is

$$-\frac{1}{x^2}$$

from the definition of the derivative.

We have

$$\frac{df}{dx} = \lim_{h \to 0} (\frac{1}{x+h} - \frac{1}{x})/h$$

$$= \lim_{h \to 0} (\frac{x-(x+h)}{(x+h)x})/h$$

$$= \lim_{h \rightarrow 0} \frac{-1}{(x+h)x}$$
$$= -\frac{1}{x^2}$$

The LaTeXcode for this little section is:

```
Prove that the derivative of
\[ f(x) = \frac{1}{x} \]
is
\[ -\frac{1}{x^2} \]
from the definition of the derivative.

We have
\[ \frac{df}{dx} = \lim_{h \rightarrow 0}
 ( \frac{1}{x+h} - \frac{1}{x})/h \]
\[ = \lim_{h \rightarrow 0}( \frac{x -(x+h)}{(x+h)x})/h \]
\[ = \lim_{h \rightarrow 0} \frac{ -1}{(x+h)x} \]
\[ = - \frac{1}{x^2} \]
```

9 How to Draw a Tribar

We may draw a Tribar by constructing an equilateral triangle in the center of a page. Add a 60 degree parallelogram on the bottom edge of the triangle, Do the same for the other two edges. Fill in the three corners. Add partial parallel edges inside the original equilateral triangle so that each corner looks like a 3d corner made from two adjacent blocks. Extend these lines to complete the Tribar. Click here for a pdf file showing these drawing steps.

`http://www.stem2.org/je/drawtribar.pdf`

10 Statistics: Regression Analysis

Suppose we have two random variables x and y. Consider the joint distribution of these two variables with joint PDF (Probability Density Function) $f(x, y)$. If x and y have some relationship they are said to be correlated, and there may exist some function say $y = g(x)$ so that the probability density tends to be concentrated near this curve. The probability density is said to **"regress"** towards this curve. Then given a sample of $\{(x_1, y_1), ..., (x_n y_n)\}$, we can attempt to find an equation for this curve. This is usually done by finding a least squares fit. The most common case is when there is a first degree linear relationship of the form

$$y = f(x) = a + bx.$$

We attempt to find the most probable value for the constants a and b. For more information click below.

`http://www.stem2.org/je/regression.pdf`

11 David Frazee: Proposed Methods for Liquifying Gases

David presented many slides, which I shall post here when I get them.

12 What is Algebraic Topology?

Topological theorems can be proved by applying algebraic theories. Some of the concepts in Algebraic Topology are: The Simplicial Complex, Homology, Cohomology, Homotopy and the Fundamental Group.

13 What is Algebraic Geometry?

Sets of polynomial equations in several variables define certain geometrical figures, called manifolds, and varieties. Thus there is a correspondence between abstract algebra and geometry.

14 What is a Differential Manifold?

A differential manifold is an n-dimensional space of geometric points, such as a 2-d surface such as the surface of the earth. Such spaces or figures can be defined as a collection of local Euclidian maps known as an atlas. So we can cover the Earth with a set of maps, but not the whole earth with a single flat map. Surfaces called Riemann Surfaces are manifolds that arise naturally in Complex Analysis.

15 What is M-Theory?

M-Theory is an extension of string theory. String theory is an attempt to simplify and solve general problems in physics by introducing higher dimensional spaces, and considering "points" as tiny 1-dimensional closed manifolds, which are called strings. The strings vibrate. The very complex theory employs Algebraic Geometry, Topology, Manifold Theory, and Differential Geometry.