Department of Mathematics
Issue 14
Newsletter 2016-2017

What We Talk About When We Talk About Math

關於數學，我說的其實是……

From the Editors' Desk 編者的話

In this issue, we have three interviews. The first is with Prof. Erica Flapan, a topologist from Pomona College. She shares with us her career advice and tips for further studies to students of mathematics, based on her own experience. This is followed by a sharing of the personal mathematical journeys of two of our alumni.

The first two interviews mainly centre around the career aspects of mathematics. The third interview with our recent graduate Kiki Ng shows that, beyond the common conception that it is something entirely abstract and unapproachable, mathematics has a more "playful" side. For example, mathematical principles are present in tiling patterns on the flat plane and the sphere, and we see in this interview that striking sculptures may be designed and built by employing these principles.

Yet another mathematical idea employed by Kiki's sculptures is that of "Fractals". Imagine building a pyramid inside a pyramid inside yet another pyramid, and repeating this process infinitely many times. The resulting structure is an example of a fractal pattern. Similar kinds of iteratively generated patterns was studied in depth in the previous century by the Polish mathematician Wacław Sierpiński. His discovery brought forth breakthroughs in our conceptual understanding of the dimensions of curves and planar patterns. The Sierpinski carpet and Sierpinski triangle, two of the most frequently invoked examples of "Sponge-like" fractal patterns, are named after him. The beauty of mathematics is a topic for ceaseless discoveries past and present.

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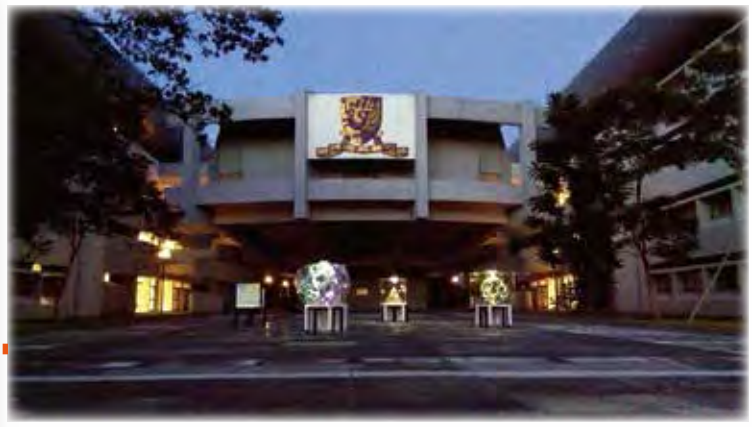


Shining Beauty of Mathematics

A Conversation with Erica Flapan

Erica Flapan is the Lingurn H. Burkhead Professor of Mathematics at Pomona College (Claremont, California, USA). Her research interests include knot theory, topology, and the applications of topology to chemistry and molecular biology. She is the recipient of numerous awards, including the Haimo Award for Distinguished College or University Teaching of Mathematics, from Mathematical Association of America. She became a fellow of the American Mathematical Society in 2012.

Earlier this year she came to the Chinese University of Hong Kong as a guest of Professor WU Zhongtao. On August 1st, 2016, in a brief respite from a hectic East Asia trip, and under the looming approach of Super Typhoon Nida, she sat down with us in a cafe in the Cheng Yu Tung Building to talk about her life, career, and advice to math students.

Flapan was born in 1956 and grew up in New York City. As a child, she did not attend a "normal" elementary school. Instead, she attended the Agnes Russell School, run by Teachers College—where her mother was a graduate student at the time—of Columbia University (New York, USA). As its name suggests, Teachers College was an institution concerned with research on education, and at the Agnes Russell school non-traditional education methods were used. "It was not really a school, it was really just a collection of children they could use to experiment on," Flapan recalled. "There was no curriculum, no grades, no tests, and no class."

With no curriculum, students were allowed to do whatever they wanted, as long as they were not being loud or disruptive. There were many math books, and Flapan liked to read them. "I just did that all the time, "Flapan said. By 6th grade she had gone through all the math books at the school—she was by that point reading books on set theory—and the school had to bring in extra ones for her.

Starting in 7th grade (at the age of twelfth), Flapan had to attend an ordinary school, and the experience proved traumatic to her. "I didn't know anything about anything, except for math," she explained. "I didn't know anything about geography, like I didn't know there was a place called China, let alone a place called Hong Kong. I didn't know anything about American History, like there had been a revolution or civil war. I didn't know anything about grammar, or spelling, or science, anything. The only thing I knew anything about was math." "To this day my spelling is not good... sometimes when I am writing, if I can't figure out the right spelling, then I use another word," she chuckled.

"I knew I was good at math. I felt like I wasn't good at anything else."

Attending this "ordinary" school, Flapan did poorly in terms of grades. She found the experience "really really difficult. It made me feel I was inferior to the other children." Consequently, starting at that time, she felt like the only thing she could do was to be a math teacher. "I didn't know of other jobs that involved math, but I knew I was good at math. I felt like I wasn't good at anything else."

Though she did not do well in other subjects, as early as 12 years of age Flapan was already doing paid jobs tutoring elementary school students in math. She was qualified to skip all of the middle school (6th-8th grades) math courses, and right away began taking high school level (9th grade onwards) mathematics. Taking high school math, Flapan observed that many students hated it, and were being disruptive in class, and she began having doubts about teaching high school. "That must be a hard job!" she thought. Later, in college, when she saw that students in college math classes weren't being as disruptive, she decided that she wanted to be a college math teacher." So, I always felt I didn't have any choice."

Starting in 1977, Flapan undertook her graduate studies at the University of Wisconsin-Madison. Recalling her graduate school years, she observed that there were very few female graduate students. "When I started there were 40 people in my entering class. Three of us were girls, and the other two dropped out within less than a month... Of the 100 faculty there were three women." One of those women was Mary Ellen Rudin—incidentally the wife of Walter Rudin, perhaps best known to math students as the author of several classic textbooks in analysis—who taught a first-year topology course that Flapan took. "And so I wanted to go into topology, because of her," Flapan told us.

The interview then turned to Flapan's views and advice on the pursuit of a post-graduate degree in mathematics, and career prospects for undergraduate math majors. Flapan told us that she would say to her undergraduate students, "If you want to get a job, based on math, you need to be sure to take a statistics course, you take a computer science course, and know some programming languages, and you take at least one economics course... and to the extent possible, know some software packages, especially statistical packages." For students who want to go to graduate school, she told them that, "You need to be strong in analysis, algebra, and then topology and geometry."

"You're going to have to learn from people who are very bad teachers."

According to Flapan, at Pomona the math major program is very flexible, and the students often make their course registration choices based on what their friends are taking, or whether they like the style or effectiveness of a particular instructor. Flapan does not feel these are good reasons for choosing which class to take. "One thing I always say to the students is, 'if you're going to get a job or if you're going to go to graduate school, you're going to have to learn from people who are very bad teachers. Even the person you think is the worst teacher in our department explains things much better than your boss is going to at a job, or than your graduate professor.'" Consequently, Flapan advises her students to "go out of their way" to take a class that everyone recommends against taking because of whatever shortcomings in the professor's teaching style. "The people who are bad teachers often leave out details," she elaborated, "They often forget the hypothesis." And then the students would have to fill in the gaps themselves. This, she believed, is a good way to prepare oneself for post-graduate studies or other jobs after school: "To be independent, and persevere."

Flapan told us that her students often went on to graduate school, but many later dropped out. She remarked that male students were more likely to drop out than female students. "Very few of my students who are female go to graduate school, but those who do generally don't drop out." She thought the reason a lot of the male students dropped out of graduate school was because "when they are in college, they are very good in math, and they don't need any perseverance. They just get it, very fast, they do it, etc. But when you go to graduate school, ultimately, it's much harder... And the students who have always succeeded because they are so smart, but not with perseverance, they drop out. They get frustrated, and they don't like this anymore."

"If you think you can't do anything else, even if it's hard you have to keep trying and trying and trying."

To Flapan, the most important character trait for being a mathematician is "perseverance." Examining herself, she said, "My perseverance was partly maybe just my personality, but partly because I have this idea that I can't do anything else. If you think you can't do anything else, even if it's hard you have to keep trying and trying and trying."

Speaking about math education-oriented careers, Flapan said that in the US, the main difficulty of being a high school math teacher is bad pay and unruly students. "Kids in America bring weapons to class, they bring drugs. It's not an easy job." On the other hand, her students often do not realize how hard it is to become a college professor. She often says to her students, while Pomona College is a highly regarded private school with good students and situated near Los Angeles, most math professors in America "teach in a very very rural location, and there are very bad students."

Regarding jobs outside of academia, Flapan told us that some of her students now plan to pursue careers in Silicon Valley. In fact, many of these students actually wanted to major in computer science, but they majored in math instead because the computer science faculty at Pomona was not large enough to accommodate all of them. Besides jobs in computer science, a lot of her students went on to careers in consulting, at companies like "Accenture, Boston Consulting Group, McKinsay." She remarked that, though a consulting career pays well, it is a hard life, with 80-hour work weeks and frequent travels to places ranging from Hong Kong to rural Kansas. Her former students often work in these companies "maybe for 5 years, and then one of the companies they were sent [by the consulting firm] to work for offers to hire them. It's cheaper for them to hire the person directly, than to have to pay the consulting company... and then they [(her former students)] don't have to move around anymore, and they don't have to work 80 hours a week anymore, and so on. So, they are willing to do this [(consulting)] for some years, and then they do something else."

According to Flapan, a third of the math majors at Pomona are international students, most of whom from Asia. "Most of those [(Asian students)] don't want to go back," she observed. "They want to get jobs in America." There are exceptions. Once she had a Chinese student who got an A+ in analysis. "I never give an A+. This guy was so much better than everyone else. At that time, I said to him, 'you really should go to math grad school, because you are really really good.' I didn't know if he knew that. And he said to me, 'But I want to go back to China for my job, and I want to do something that is going to help my country.'"

博士“後”的遼闊天空

傳統概念上，博士生畢業後最好的工作就是當一名博士後研究員，待幾年後再在研究型大學找一份教席。現代社會改變，博士生的出路不用局限於學術圈內。

許多人都有一個美麗的誤會，認為最出色、最有能力的人就會留下來做研究，沒辦法留下的失敗者才須要向外謀求工作，這種想法只是一種情意結。說真的，世上沒有一樣工作比另一樣更高尚，現實世界中，有不少能力強的博士生會主動往其他行業走。

認識一位女孩子，她當研究員兩年後，已獲得英國一所大學的講師職位（相當於美國的助理教授）。對於想留在學術界的人來說，這份工作是相當吸引的，可是她覺得做研究做膩了，便到銀行界找工作去。

除此之外，身旁有一堆在一流大學唸博士的朋友，他們有些因為家庭經濟，有些也是覺得做研究做悶了，就去找其他工作。他們的論文絕對不是差，有的甚至在畢業前已經發表了幾篇文章，於他們而言，離開學術界是在自己的職業規劃下，一個主動的決定，而非被逼離開。

另有一些人，在讀書的過程中發現自己喜歡教學多於研究，畢業後便去找一些教學型大學的教席。我認識過一位博士生，就是因為熱愛教學，一畢業便到社區大學教書。他的指導老師公開說過，他是多年來門下最好的學生，要是他願意做研究，肯定很出色。但這位老師同時指出，該學生能找到自己的人生方向，也是一件好事。

數理博士生畢業後，如不待在學術界，大部分人都會尋找教書、金融或寫程式的工作。跟數學有關的工種好像不多，但只要多點跟不同的人聊聊，就會發現其實機會處處。以我為例，有人曾提議我去做城市規劃，也有人說很想招聘數學系出身的人，不停慫恿我到超級市場計算哪些貨物應該減價。同學圈中，有些去了油公司，有些去遊戲公司計算勝負的概率，也有些去了物流公司。此外，跟不同學科的教授閒談中，他們都希望找數學出身的人幫忙。有一位工程教授跟我說，要是我找不到工作，他很願意聘請我做研究員。最有趣的是另一位做音樂研究的，由於研究牽涉到代數拓撲，很希望有讀純數的人跟他合作，還不停拉着我說他的研究方向。

世界很闊，人生的選擇也很多，唸完博士後實在用不着把自己鎖在某一種工作裏。唸博所學得的技巧可應用於不同的範疇，讀書的同時，花點時間了解不同行業及其所需的技能，也許會更清楚自己未來的路要怎樣走。

（數學系校友）

璀璨數學之美 Shining Beauty of Mathematics

大學四年晃眼便過，在這段夢與想交織的青春歲月裏，畢業生希望為自己留下怎麼樣的回憶？本系吳彥琪同學臨近畢業前，於百萬大道舉行了一場名為「璀璨數學之美」的展覽，以三個幾何圖形拼合而成的雕塑及地上的幾何密鋪，配合用色、場地佈置和燈光效果，展示數學在她心目中的美。讓她親自談談這次難忘的經歷。

為甚麼想舉辦這類型展覽？

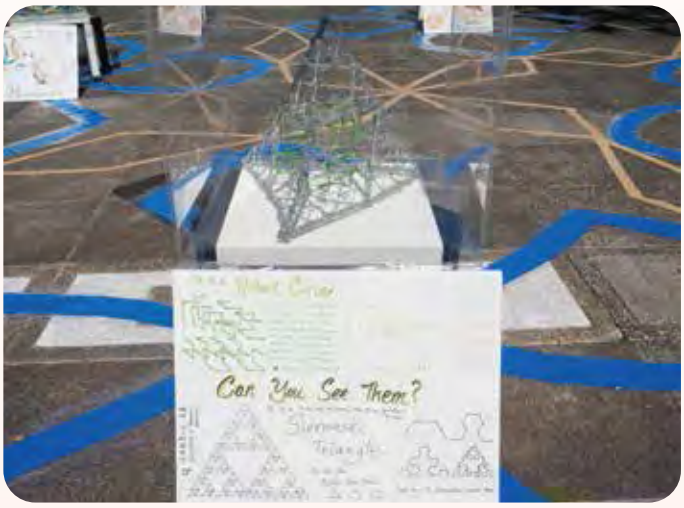
考最後一個期末試前，我偶然在facebook看到台灣一個特別的展覽：「超越無限數學印象特展」，展場佈置得美輪美奐，一個個滲著數學元素的大型雕塑直立其中，概念十分新穎、有趣。我深受啟發，希望也能在中大舉辦類似的小型展覽，把熱愛的數學與藝術結合起來，跟大家分享，數學其實很美。

你可以用其中一項展品說明，怎樣呈現數學之美嗎？

先談談數學的語言。我認為它是人類為求了解大自然的運行規律，而創作出來與大自然溝通、互動以至想像著未知世界的語言。數學之美就像文章之美，美在其表達的主旨，也美在其表達的手法。專注做數學的人，往往會為了一條破解得巧妙的證明而欣喜不已，這或許跟一個熱愛文字創作的人閉門覓句、終喜獲良賦而深感滿足有異曲同工之妙。文學中有凝練的詩歌、優雅的散文、感人的小說等類別，數學之美亦可以有不同的呈現。而我特別鍾情以簡潔的對稱規律和密鋪設計來呈現數學之美，於是「幾何」便成了是次展覽的主題。

展覽中其中一個以六十件輕木砌成的雕塑，除了有俐落的對稱線條外，仔細看可以發現在三維空間裏，每一塊輕木都落在不同的平面上，指向不同的方向。當這些平面部件「三五成群」—每三件、每五件連接在一起時，突角遠看起來竟然都像彎曲的凸面！這種從對稱而生的和諧並非憑空拼合，乃源於五角化六十面體的特點，每一個突角都對應著六十面體中、面與面之間接觸的共端點，是數學幾何體分支的學問。正幾何體（如正方體）在大自然中很容易找到，不知道這些由數學推導出來的幾何體，會否真的也存在於大自然中呢！這些展品悅人眼目，背後蘊含理論的推導，也帶著大自然神秘的色彩，都讓我由衷讚嘆數學的美。

展品1

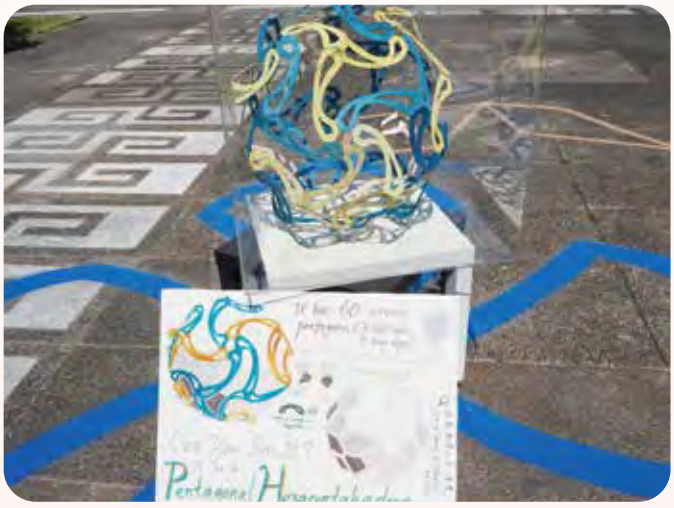


意念原型：
謝爾賓斯三角形 (Sierpinski triangle)

特點：
每一個正三角形裏，沿三邊中點的連線，分成四個小正三角形。除中間的小三角形，又重複分成更小的三角形。中間是一條能填滿正方形的空間填充曲線。

材料:
銀色鐵線、綠色及黃色鋁線

展品2



意念原型:
五角化六十面體 (Pentagonal hexecontahedron)

特點:
由六十個非正五邊形組成的凸面體，組件的接駁位分別對應著五邊形之間的共端點。

材料:
輕木、藍色及黃色塑膠彩、鐵線

過程是否如想像中順利？

我本來只打算舉行一至兩天的短期展覽，並構思用紙皮和藤枝來創作雕塑，沒有想過保護展品的問題。後來得到區國強教授的支持，展期得以延長，如何保護展品便讓毫無展覽經驗的自己頭痛不已。幸獲藝術系及設計系朋友的提點，最後才發現用透明膠片箱能令雕塑保存得更經久耐看。另一件驚險的事情是，我忘了預測完成品的闊度，快要完成時才驚覺這問題，雕塑險些過大而出不了門！如果只有自己兼顧藝術創作和展覽籌辦，這些準備功夫相信花一個月也做不來，幸好得到不同人的幫忙，才能用幾天時間完成，讓我可以專心做展品。在此，希望再次感謝支持展覽的區教授，協助場地統籌的理學院和數學系職員，幫助我完成作品的同學，以及過程中一直鼓勵我的朋友。

如果日後師弟、妹有意參與類似的 science crossover計劃，你有何建議？

Science crossover的目的是鼓勵同學用另類的方式探索科學，參與者最好對科學以外的一些科目同樣感興趣，然後懷著好奇心和熱誠把想法付諸行動。最重要的是，如區教授所言，「為了好玩而已。」好玩是我從開始至完成這個展覽的主要動力之一！

展品現於邵逸夫夫人樓二樓數學系走廊展出。如想了解更多，可登上璀璨數學之美的facebook專頁:

https://www.facebook.com/ShiningBeautyofMaths/

展品3

意念原型：
菱形六十面體 (Rhombic hexecontahedron)

特點：
六十塊組件構成了十二個凹面的迴旋五邊形

材料：
紫色及綠色珍珠板

場地佈置

意念原型：
密鋪平面設計，參考自 <Shells and Starfish> M.C. Escher

材料：
藍色及橙色膠條

Department News

本系精英榮獲國際獎項

數學系副教授雷樂銘、研究助理教授邱宇、及博士畢業生馬梓銘分別獲得「晨興數學銀獎」、「代數表示論國際會議獎」及「新世界數學獎」的「博士論文金獎」。這三項國際數學獎中，中大是本港獲得獎項的唯一院校。此外，本系退休教授岑嘉評亦獲授2016年度的「保羅・厄度士獎」(Paul Erdös Award)，岑教授是獲得此殊榮的首位香港數學家。

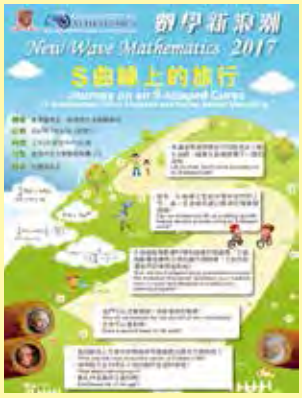
2016年恒隆數學獎

由中大數學系、數學科學研究所和恒隆地產合辦的2016年恒隆數學獎，吸引了近60間中學約80隊學生參加。經過一輪評審，恒隆數學獎的「學術委員會」選出十二隊入圍隊伍進行12月14日的答辯會，得獎名單已於12月15日的頒獎典禮上公佈。何明華會督銀禧中學的梁辰楷同學勇奪金獎。何同學現時就讀本系一年級，入圍名單中共五名同學正於本系就讀。

Coming Events

New Wave Mathematics Series
數學新浪潮講座

S曲線上的旅行
Journey on an S-shaped Curve



- 愛因斯坦人生當中的學術研究高峰期出現在什麼時候？
- 海明威又在何時步入他的創作全盛時期呢？
- 莫札特是壽終正寢的嗎？
- 我們可以怎樣預測一項新發明的興衰？
- 生命可以重來嗎？
- S 曲線能夠影響科學和商業的發展嗎？它能夠影響音樂和文學的創作過程嗎？它如何影響我們的學習進程呢？
- 甚至，S 曲線又是如何預知我們的人生—這一生老病死變幻莫測的複雜歷程呢？
- 本講座帶領同學從不同視角來了解 S 曲線，隨著 S 曲線展開不一樣的旅程。

講者：黃澤富博士
日期：2017年3月11日 (星期六)
時間：上午10:30 — 中午12:00
地點：香港中文大學 鄭裕彤樓 LT1

(歡迎參加 無須報名)

Enrichment Programme for Young Mathematics Talents (EPYMT) 2017
數學英才精進課程2017

培育新一代數學人材
新高中學生暑期課程

時段：2017年暑假 (確實日期待定)

請密切留意課程網頁：
http://epymt.math.cuhk.edu.hk