

An Interview with Tony Chan

by S.H. Lui

Tony Chan is currently Professor of Mathematics at UCLA. He obtained his B.Sc. and M.Sc. at Caltech in 1973; and his Ph.D. in computer science at Stanford in 1978, under the supervision of Joe Oliner. He held a postdoc position at Caltech from Jan 1978 - Sept 79. From 1979 to 1985, he was assistant professor at the computer science department at Yale. His sabbatical year 1985-86 was spent at HKU and RIACS. Since 1986, he has been on the faculty of mathematics at UCLA. He has published many papers in numerical analysis and is an editor of several leading journals including the SIAM Review. Prof Chan is a frequent visitor to Hong Kong. He is a very dynamic person and his influence permeates many areas of numerical analysis. He is visiting CUHK during the fall term of 1994. This interview took place on Nov 14 and Dec 7. My special thanks to Tony for making numerous suggestions and additions to an earlier draft.

Lui: Can you give an account of your education?

Chan: I was born in Hong Kong. I attended the Salesian Catholic School in Shau Kei Wan until Form 5. The school had just started Form 6 in time for me and I attended for a couple of weeks before switching to Queen's College. I wanted to go to Queen's because this school was (and still is) well-known as a very good school. But the way I got in was quite dramatic. The minimum requirement just to get an application form for this school was 7 credits in the School Certification Exams. I had one distinction (in Math of course) and 6 credits so I barely qualified and was subsequently put on the waiting list. [The grades for the courses are classified as distinction, credit, pass and failure.] A classmate of mine who did get in told me 2 weeks after school had started that there were several empty seats in the classroom and suggested that I arrange for an interview with the Principal. I was very shy at that time and was reluctant to go but my mother urged me to go. I went and was accepted on the spot. This was truly a turning point in my life. At Queen's,

the teachers were excellent and the students all had something special about them. The entire atmosphere was so much better than my old school. There is a lesson to be learnt here. Given a chance, you should grab it, otherwise you may regret it later.

At that time, the best A-level students in science and engineering wanted to go to the EE department at HKU and that was what I had planned to do. However, it didn't turn out that way. I remember one day in class in Form 7, we found a magazine lying around with an article on Feynman and Gell-Mann, both professors at Caltech and who had recently won the Nobel Prize in Physics. My classmate Kwok Hoi-Sing, who is now a professor of EEE at HKUST, and I became highly motivated and we decided to try applying to study (presumably physics) in the US. My hopes were boosted after I took the SAT and did quite well (four 800 scores). Of course I applied to Caltech, helped by that fact that it was among the few universities which didn't (and still doesn't I've heard) charge an application fee. I also applied to the Northrop Institute of Technology (related to the big aerospace firm with the same name but mainly a vocational training school) because I was also interested in aeronautics, having grown up in Ah Kung Ngam on the takeoff path of the Kai Tak runway and fascinated by those planes and wondered how these metal birds can fly! I was accepted by both NIT and Caltech. At that time, I did not know the difference between them. I'm glad I chose the latter!

Even though I had already decided to go to Caltech, I did apply to HKU since I had already taken the matriculation exams by that time. Another classmate of mine had decided to switch from engineering to medicine and I followed his example and applied to the medical faculty at HKU, figuring if I stayed with engineering I would definitely go to Caltech. To our surprise, we were both accepted. This was very remarkable because HKU medicine was the most difficult faculty to get in and neither one of us had any A-level courses in biology! Even though I finally decided to go to the US, I still have a lot of respect for the admission people at HKU who had decided against all odds to take a chance on us. My classmate is now a very successful doctor in HK.

To get into Caltech, in addition to taking a very tough written exam, every applicant had to be interviewed by a panel of about 10 US professors from various universities who travelled around the world to interview students. It was a very intimidating experience. One professor asked me what I wanted

to do after I graduate. I told him that I wanted to teach in college. He laughed, probably thinking that some of the (US) students may be a little too tough for me. Well, that may still be true but I am fulfilling my promise.

The admission officer at Caltech that year turned out to be Prof. Sunney Chan (who has recently decided to take up a high level position at CUHK). He personally talked the Caltech president into admitting about 12 Hong Kong students, which was a significant percentage of the incoming freshman class, numbering around 250. Before that year, Caltech never had a significant number of students from HK. Because our batch did well, Caltech later admitted many more students from HK. We all owe Prof. Chan a big debt.

At Caltech, I initially chose Physics as my major. However, I found the concepts in Physics to be rather vague and abstract (we were using the Feymann lecture notes of course). Even though I scored well in the the homeworks and tests, I did not feel comfortable or gain any confidence. So I later switched and obtained a B.Sc. in Engineering and a M.Sc. in Aeronautics. At Caltech, theoretical aeronautical engineering is just applied math and I took many courses in applied math. I remember never once did any professor discuss the actual construction or flying of an aircraft. The emphasis was on the study of the fundamental governing PDE's and their solutions. In my senior year, I remember asking one of my professors how we build airplanes if we can only solve the Navier-Stokes equations over a flat plate analytically. He told me that we use the computer and numerical methods. I then decided to study computing. I talked to several professors and in particular Prof. Joel Franklin suggested that I study computer science (a relatively young field at the time) at Stanford. He told me there were two excellent professors there, Knuth and Golub. It turned out that Golub had given a talk earlier at Caltech on computing the SVD and I sort of understood and liked it. But I did not make the connection that this was the Golub from Stanford. (When I was a senior, I tried to attend every Applied Math and Aeronautics seminar at Caltech. Even though I didn't understand very much of the talks, I find this experience to be invaluable and I urge all my students to attend seminars.)

I applied to many graduate schools in the US. My goal was to study applied math and computer science. Applied math was done at different departments at different universities and it wasn't easy to find out which department to apply to. I remember applying to the Berkeley math department and got back a letter telling me that I shouldn't study mathematics

because there would be no jobs for me after I graduate. So the current job crisis in math is nothing new.

I drove up to Stanford, liked the campus and enrolled there. But the first few months at Stanford were tough. There were about 20 first year graduate students in computer science that year and all but two (myself and Franklin Luk, who visited CUHK last year and is chair of the CS department at RPI) were computer wizards. They had written compilers and the like while I barely knew how to run small programs in FORTRAN and BASIC. We had to learn the programming language ALGOL and do an assignment all in the first week. We quickly caught on and things worked out at the end.

The numerical analysis group at Stanford was housed in a small 2-storey house, the legendary Serra House, which used to be the residence of the Stanford president. It was a very special place. It was a real house and had a kitchen, fireplace, showers, basement etc.. I literally lived there during my graduate career. I also met many renowned applied mathematicians passing through there. I remember at my first meeting with Prof. Golub, he gave me a deck of cards containing a FFT fast Poisson solver. Unfortunately, I didn't make much progress with it but of course his work in this area is now well-known. One nice thing about Serra House was that the graduate student offices were adjacent to the professor offices and there was constant and open interaction. At Stanford, I learned as much from my fellow students as from any professor.

As is obvious from my background, I was not trained as a pure mathematician. None of my degrees are in math. For me, math is a tool used to solve problems. Of course, I can appreciate a beautiful theorem in pure math but I don't consider myself as a practitioner of that art. Now that I'm in a math department, I think I have become more mathematical in my approach to problems which has added a new dimension to my work.

Lui: Did any teacher influence you greatly?

Chan: At Salesian, an Irish priest Father Cochran taught me English, not the usual things expounded in schools but how to speak and use English (e.g., how to pronounce "r" and "v", which are particularly troublesome for Cantonese people). I taught him some Cantonese at his quarter. He was also the coach of the school soccer team. We were the number one team in Hong Kong. Actually, several of my team-mates later became professional

soccer players in Hong Kong. Father Cochran emphasized both academics and sports. I was reasonable in both and so he liked me and always used me as an example.

Professionally, I have been greatly influenced by Prof. Gene Golub. His style, his treatment of students, his devotion to the profession and his works have provided constant motivation for me over the years. Even though I was not formally his Ph.D. student, I think even many close colleagues of mine think I was. I never bothered to correct this because in many ways he is indeed my mentor.

Lui: You did a postdoc at Caltech after graduation.

Chan: I had two offers at the time of graduation: an assistant professorship at RPI and a postdoc at Caltech. Joe Keller had just recently moved to Stanford and he was the perfect person to consult because he knew the faculty at RPI well and the person I wanted to work with at Caltech was Herb Keller, Joe's brother. Joe advised me to go to Caltech and I took his advice. This was a pivotal decision in my career because Herb had just recently worked out his continuation algorithms for nonlinear eigenvalue problems and Achi Brandt had just published his seminal paper on multigrid and he was visiting Caltech at the same time. I still work on these topics now.

Lui: Yale was next.

Chan: Yes, I had several offers, including an assistant professorship at Harvard, but I decided to go to Yale's computer science department. Martin Schultz and Stan Eisenstat had just started a Research Center in Scientific Computing and it was an excellent place to work. They were many young hot-shot numerical analysts who went through there at that time and are now prominent people in our field, including Ken Jackson, Youcef Saad, Bill Gropp, Ilse Ipsen, Joel Saltz and Vladimir Rohklin. Randy Bank visited for 1 year and we became collaborators. There were also many good graduate students including Craig Douglas, Howard Elman, Alan Weiser, Tom Kerkhoven, Leslie Greengard, Faisal Saied and Liz Jessup. I was privileged to witness the birth of the GMRES and the Fast Multipole algorithms! Yale is one of the very few universities where scientific computing is flourishing in a computer science department.

Lui: In '85, you came to UCLA.

Chan: In '83, I got an offer from the CS Dept. at CUHK and I almost went there because my US H-1 visa was about to expire and my green card application had still not been approved. By a fortunate turn of event, they processed my green card just in time and I stayed at Yale. During my sabbatical year in '85, I spent 3 months at the Computer Studies Division at HKU (which later became the computer science department) and at RIACS/NASA Ames. During that sabbatical, I got an offer from UCLA and I accepted it without returning to Yale. At that time, Stan Osher and Bjorn Engquist were about the only computational mathematicians at UCLA. However, the provost had just decided to build up the applied math program and many good people were recruited within a few years: C. Anderson, H. Kreiss, P. Roberts and R. Caflisch. The number of graduate students in applied math has also grown tremendously. Our computing facilities in the beginning were abysmal. Now, they are better than those at the computer science department. At UCLA, pure and applied mathematicians get along quite well together. In the mid '80s, we had the first wave of mainland Chinese students and they were absolutely first rate: T. Hou (now at Caltech) and Weinan E (now at Courant) just to name two. Recently, we are lucky to get several excellent students from Hong Kong. Since they have been doing so well, I think our faculty has a very positive impression of the quality of students from HK and I strongly encourage HK students to apply to our program.

Lui: Any comments on the development of computational math and scientific computing in HK?

Chan: Since '85, I've been visiting HK almost every year, mostly to work with Raymond Chan. We have published several papers together and we are still collaborating. Raymond and I always encourage international mathematicians to visit Hong Kong when they travel to this part of the world, e.g., on their way to/from China. In particular, we are organizing a conference in May 95 as part of an international conference in Beijing and also a winter school in iterative methods in December 95 with many leading people already committed to come to HK.

My observation is that there has been a tremendous growth in research in Hong Kong in the last few years. Hong Kong is now quite well-known in the

academic world around the globe. Of course, a main stimulus is increased research funding from the UPGC. But another important factor seems to be the birth of HKUST. Now every school must compete for faculty, graduate students and grants. I think this is a healthy development. Also, I have witnessed the emergence of several new degree programs in computational math and scientific computing in recent years. This is a very welcomed development from my point of view. I understand that fewer and fewer students are interested in math and science in general and that these programs are partly a response to this crisis but they should also be viewed as valuable in themselves. These new programs should attract more good students into math departments and provide a link to the engineering and science departments and hopefully the local industry as well. The difficulty I see is that there is no industrial base and research infrastructure and tradition in HK. How do the graduates find employment where they can apply their skills? This seems to be a chicken and egg problem. Without the trained graduates it is difficult to develop the related hi-tech industries but without the industries it is difficult to find relevant jobs for the graduates. Maybe this is where the government can play a role, like in Singapore and Taiwan. One solution is more cooperation with China. I think a good role for Hong Kong to play is as an information exchange center in East Asia.

Lui: How do you do mathematics? How do you choose problems to work on?

Chan: I'm mostly motivated by applications, perhaps because of my background in engineering. The thing that I work on must have an application. This doesn't mean that I will actually carry out the application. I'm interested in many things. I attend a lot of seminars. This is very important because one gets different approaches and motivations to different problems. Even if I don't understand the lecture completely, I will get something by osmosis. I get a global view of things. Very often, ideas from one area can be used in another area. I have benefited from this many times in my work.

Lui: What is your philosophy in teaching undergraduates and supervising graduate students?

Chan: I have supervised about 10 Ph.D. students and 5 postdocs. I have

found that it is very difficult to be a good advisor. The key is to be adaptive. Every student is different and we must try to bring out the best in each. Ideally, I like to treat the student as a research partner but I also have to leave enough room for the student to learn to work independently. Good students are precious gems and they help you grow as much as you help them.

As far as undergraduate teaching is concerned, I emphasize the understanding rather than the curriculum. I think it is better to understand a few things well rather than to know a lot of things superficially.

Lui: Many schools are starting scientific computation programs. What sort of things should be taught?

Chan: There should be three components: application, math and computers. We should try to identify the applications specific to Hong Kong. This may be finance, information processing, pollution modeling or some other area. In the US and Europe, the main “consumers” of computational math have been the defense and heavy industries (e.g., oil and auto). HK has neither and it must find its own local applications. What works in the US and Europe may not work in HK. For example, fluid dynamics has traditionally played a dominant role for the development of applied and computational math in the US and Europe because of the defense industry but this role has diminished after the fall of the Soviet empire. The US government is now emphasizing research with demonstrable impact on the national economy and competitiveness. I think this is a role that HK can follow to some extent.

Lui: What is your favorite algorithm?

Chan: Multigrid. It is one of the most important and powerful paradigms in computational math and can be (and has been) applied to many problems.

Lui: Do you have any mathematical heroes?

Chan: John Von Neumann. He was a pioneer and made important and lasting impact in all three components of scientific computing I mentioned before: application, math and computers. I think he is unique in this sense.

Lui: What are some of the challenges in scientific computation in the 21st

century?

Chan: Scientific computation changes with application and time. I believe that the driver should be the applications. The challenge is to identify them and develop the necessary math and computing methods to help solve them. I believe information processing (e.g., speech and image processing), biological and medical applications, computational intelligence (e.g., neural networks, fuzzy logic, etc.) and parallel computation (particularly software interface) are among the new challenges.

Lui: What are some differences between students of US and Hong Kong?

Chan: Hong Kong students are more passive, at least in public. They usually have good formal training but may not be as adventurous. But they certainly give more respect to the professors.

Lui: Do you have any hobbies?

Chan: I like to play tennis and travel. I meet many friends all over the world through these two hobbies. And being a professor gives me many opportunities to do both.

Lui: You've lectured all over the world. Would you like to share any tales with us?

Chan: I have many tales to tell but what I enjoy most is the fact that in almost all the countries that I have visited, I usually know someone professionally who can serve as a local guide. I often get invited to visit the home of local scientists. I think I get a more in-depth view of the place I visit than a typical tourist.

Below are some notable tales from my travels. Some are quite dramatic while others are memorable on a personal level.

First, the dramatic ones:

- **India:** The most dramatic trip I have taken was my first trip to India (from HK in 92) to attend a meeting in Bangalore. While I was flying from Delhi to Bangalore on Dec 6, 1992, the Ayodyha riot broke out. Many cities were under curfew (more than 50 people were killed in Bangalore alone) and some participants (including Beresford Parlett)

were stranded on their way to the conference. To make matters worse, the domestic airline pilots went on strike. People were starting to worry whether they can get out of India safely. The official conference excursion was cancelled but I managed to arrange one of my own to three historical sites. We passed many army trucks on that trip and many towns were still under curfew. I ended up in Bombay a day after a big riot there and all flights to Delhi were cancelled. I managed to fly back directly to HK from Bombay on another flight. But my safety was never in doubt and I was invited to a very memorable dinner at the home of an Indian student of Joe Olinger's from Stanford. I actually left India with a strong desire to return.

- **USSR:** I was invited by Yuri Kuznetsov to visit Moscow and Novosibirsk in 1988. It was my first trip to the USSR. I obtained a visa and even though I couldn't understand a single word of the Russian written on it, everything seemed OK. After I spent a few days in Moscow, it was time to go to Novosibirsk. Someone took me to the airport, passports and visas were checked several times, and I finally found myself at the bottom of the stairs to board the plane. At that moment, another check on my visa was made and I was told that I didn't have the visa to visit Novosibirsk! I didn't know that you needed a visa to visit each city in the USSR and even though Novosibirsk was on my invitational letter, it was somehow left off the visa. And of course I wasn't aware of it because I couldn't read Russian! Now my escort from the Academy had already left the airport and I was stranded there, not knowing a single word of Russian. It was one of the most desperate moments in my life! Somehow I managed to call Kuznetsov and the escort was sent back to pick me up. The next day, we went all over Moscow to get that "missing" visa and in the afternoon we went back to the airport again. No luck this time either because all seats to Novosibirsk were booked solid for the next 2 months! To this day, I still haven't had the privilege of setting foot in Novosibirsk.

I returned to Moscow in 1990 for a conference and by that time one could see that the country was in a crisis. Food was in short supply and even restaurants in big hotels could serve only a handful of items on their big menus. I did not know that the empire would collapse soon afterwards but I could sense that things were not going well. My

departure from that visit was also quite dramatic. My return flight (one of the last Pan Am flights!) was to depart from Leningrad at 6am — a bit early but nothing alarming. Except that no taxis operated after midnight! So I had to arrive at the airport about 1am and wait several hours. At a modern airport this should not be a problem. But the Leningrad airport was surprisingly small and it had basically shut down by the time I arrived. There was no light, no heat, and nobody around! I was freezing (it was May) and sleeping was out of consideration. Later on some airline employees started to show up and I managed to borrow a blanket. The US seemed like paradise when I returned.

- **Taiwan:** I was invited to give a 2 week lecture course in Tsinghua Univ. in Dec. 1990. I went with my wife and 2 young kids and I was joined by my parents from HK. It was my father's first visit to Taiwan since 1948! During the weekend in between, we decided to rent a car and visit the East coast (Hualin area). The drive was quite pleasant until we reached the last section, a supposedly scenic highway similar to Hwy 1 along the California coast. It turned out that because December was the off tourist season, a massive road work improvement project was under way. A normally one hour drive took more than 3 hours. We were driving on dirt road, through unfinished tunnels with workmen still drilling in them and water dripping everywhere. We had to dodge between big cranes and drills, at the same time trying to not get too close to the edge of the cliff. And all this with 3 generations of my family in my hands. I grew a few white hairs on that trip but the gorges at Hualin was worth it.
- **Mexico:** My first trip to Mexico was around 1985 to attend a meeting in Guanauato, an incredibly pretty colonial town about 150 miles NW of Mexico City. I rented a car with Bob Skeel and his wife and Margaret Wright (now SIAM president-elect) and her daughter and the plan was to drive to Guanauato. On the map it seemed like it should take no more than 3 hours, using our American instinct. However, we had not anticipated several uniquely Mexican factors. First, the “map” supplied by the local Hertz was more like a treasure map than a Michellin map — merely a sketch with a few hand-drawn landmarks. Then there

was the notorious Mexico City traffic. We were also hit by severe thunderstorms on the way. But the worst part was that Hertz had no cars with automatic transmission and I was the only driver who could handle a stick shift. That meant I had to drive the whole 5 hours with no relief, first through Mexico City traffic, then through deserted countrysides with thunderstorms and lightnings, and with nobody in our car speaking a word of Spanish! Somehow we survived the trip and Bob and Margaret and I remain good friends, much like survivors of other dramatic events!

- **Altitude Sickness:** At the first Copper Mountain Multigrid Conference in 1984, I discovered that I suffer from altitude sickness. The hotel was at 10,000 feet. I woke up the first night thinking I was having a heart attack and woke up my room-mate (poor Randy Bank) to call the hospital. Since then I have discovered that one night of acclimatization at Denver or Boulder cures the problem.

Now the memorable ones:

- **US:** When I went to Caltech, it was my first trip abroad (except for Macau) and my first plane trip. It was a Pan Am flight in a Boeing 707. I was so fascinated by the view above the clouds that I took a whole roll of film through the window. We had to make refueling stops in Osaka and Anchorage before arriving in San Francisco. I have since then waited for a non-stop HK-LA flight but it took more than 20 years before the new 747-400 made this possible. When I finally arrived in Pasadena, the smog was so bad in LA that it took me more than one week before I realized the presence of the nearby San Gabriel mountain. Due to strict pollution control over the years, the air quality in LA has actually improved tremendously. In contrast, it is sad to visit the now polluted beaches in HK and remember what they were like when I was a kid. HK must tackle the pollution problem before it poisons its citizens.
- **China:** Like many HK born people of my age, we were discouraged from visiting mainland China because it was thought to jeopardize our chance of studying in the US. It was rumoured that the CIA blacklisted those who visited China. My first trip to China was not until 1978,

shortly after the Cultural Revolution. I met some relatives for the first time. Through contacts set up by Prof. Ken Young (now Pro-VC at CUHK), I visited the Zhong-shan Univ. (where my father got his degree) and South China Technical Univ. China was quite backward in those days. I remember giving a talk on multigrid and was shown some locally produced computers with a tape reader. Somehow these hi-tech things seemed completely out of place. I returned to Guangzhou earlier this year. It was unimaginable in 1978 the amount of progress and change that has been made in the last 15 years.

- **Europe:** Just as memorable was my first trip to Europe in 1983, at the invitation of Roland Glowinski to visit INRIA near Versailles. I remember the excitement when I first sighted the European coastline from my window seat on the plane. The 3 months my wife and I lived in Paris are still vivid in our minds. Driving alone from Dover through London to Harwell in a left-hand-drive car at night and driving on the speed-limit-less autobahn prepared me well for the traffic of Hong Kong.
- **East Berlin:** I visited Peter Deufflehard's math institute in Berlin in June 1990. It was shortly after the Berlin wall had fallen. In the audience of my seminar was a East German scientist who later invited me to visit East Berlin and in particular his own apartment. East Berlin was the central part of the historical city and it was full of monuments and museums. I remember returning that evening on my own to attend a concert in the historical opera house. It was a truly historical period and I was lucky to be there to experience it.
- **Arctic Circle:** I was invited by IBM to give a lecture at a conference at Tromsø, Norway. The city was inside the arctic circle and it was June so the sun really never completely set. We had a midnight-sun lecture and ironically it was in a darkened indoor auditorium.