UK IMO team leader's report

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The International Mathematical Olympiad was held under an African sky for the first time. The event was held in Cape Town, South Africa, during July 2014 and was a great success. The director, John Webb, is a stalwart of the maths competition circuit, and bringing the event home to Cape Town is the fulfilment of a long cherished ambition. The event was held under the auspices of the South African Mathematics Foundation, but they had help from many sources, including businesses, charities, foundations, government, private individuals and universities.

The IMO is the world championship of secondary school mathematics, and is held each July in a host country somewhere in the world. A modern IMO involves more than 100 countries, representing over 90% of the world's population. The competition was founded in 1959. Each participating country may send up to six team members, who must be under 20 years of age and not have entered university.

The University of Cape Town was the students' site, and it nestles dramatically on the lower slopes of Table Mountain, on land donated by Cecil Rhodes. It was cold at night, but we were well warned in advance, and warm jackets were supplied. The organization was very good indeed, but in an event so large and complex as the IMO, it is impossible to get everything exactly right (unless you are Dutch). Indeed, that is the basis of the more cruel aspects of the UK leader's diary which serve to highlight, dramatise, and if necessary fabricate apparent shortcomings.

The UK Deputy Leader was Dominic Yeo of the University of Oxford, and our Observer C was Jill Parker, formerly of the University of Bath. Here is the UK IMO team of 2014.

Joe Benton	St Paul's School, Barnes, London
Gabriel Gendler	Queen Elizabeth's School, Barnet, London
Frank Zhenyu Han	Dulwich College, London
Freddie Illingworth	Magdalen College School, Oxford
Warren Li	Fulford School, York
Harvey Yau	Ysgol Dyffryn Taf, Carmarthenshire, Wales

First reserve was Neel Nanda of Latymer School, Edmonton, London.

For the second year running, each UK student scored at least 20 points. This has not happened since the run of three similarly successful years during 1994 – 1996. We look forward to the results of IMO 2015 in Chiang Mai, Thailand with interest. Note that Warren Li has two more years at school, Joe Benton has three, and Harvey Yau has four. The future prospects of the UK IMO side look healthy.

Name	P1	P2	P3	P4	P5	P6	Σ	award
Joe Benton	7	5	1	7	4	0	24	Silver
Gabriel Gendler	7	6	0	7	2	0	22	Silver
Frank Zhenyu Han	7	4	0	7	2	0	20	Bronze
Freddie Illingworth	5	7	0	7	2	0	21	Bronze
Warren Li	7	7	0	7	7	0	28	Silver
Harvey Yau	7	6	0	7	7	0	27	Silver

There are three problems to address on each of two consecutive days. Each exam lasts 4 hours 30 minutes. The cut-offs were 16 for bronze, 22 for silver and 29 for gold.

There were 101 teams at IMO 2014. Warm congratulations to China and the USA for excellent performances. Special celebrations are in order for 3rd placed Taiwan because that is their highest ever ranking, and for Ukraine which equalled its highest ever ranking of 6th. The 13th place for the Netherlands is their best rank position since 1983.

Here are a few of the leading scores. 1 China (201), 2 USA (193), 3 Taiwan (192), 4 Russia (191), 5 Japan (177), 6 Ukraine (175), 7 South Korea (172), 8 Singapore (161), 9 Canada (159), 10 Vietnam (157), 11 Australia (156), 11 Romania (156), 13 Netherlands (155), 14 North Korea (154), 15 Hungary (153), 16 Germany (152), 17 Turkey (147), 18 Hong Kong (143), 18 Israel (143), 20 United Kingdom (142), 21 Iran (131), 21 Thailand (131), 23 Kazakhstan (129), 23 Malaysia (129), 23 Serbia (129), 26 Italy (128), 26 Mexico (128), 26 Poland (128), 29 Croatia (126), 29 Indonesia (126), 29 (Peru) (126).

Anglophone interest in other scores might include 39 India (110), our neighbours and traditional allies 45 France (96), 53 Bangladesh (84), 54 Sri Lanka (82), 60 New Zealand (76), 64 Ireland (67), 64 South Africa (67), 72 Cyprus (53), 75 Pakistan (50), 82 Trinidad and Tobago (32). It was simply excellent to see delegations from Burkina Faso, Gambia, Ghana and Tanzania competing at an IMO for the first time.

Here are the unusual prizewinners for 2014. The first country to have its rank higher than its score was Latvia. The team leader with the most names was from Brazil (5), only one debatable word ahead of the leaders of Bolivia, Cuba, Mexico, Nigeria, Puerto Rico, Vietnam and Uruguay. However, in the leaders' nominal accents competition, Vietnam (four with three different) was a clear winner since no other leader had more than two accents (but Serbia had two accents

and a crossed D). Japan was the top constitutional monarchy, and Luxembourg managed to retain the Grand Duchy title. The UK was the 4th Commonwealth country, which actually indicates excellent performances from Singapore, Canada and Australia. Romania topped the European Union and Netherlands the euro area.

The second bullet point of General Regulation 2.8 may or may not apply in 2015, so you might have three IMO teams from the Atlantic Islands next year.

The Papers

Contestants have 4 hours 30 minutes to sit each paper. The three problems on each paper are each marked out of 7. It is intended that the three problems should be in increasing order of difficulty on each day.

Day 1

Problem 1 Let $a_0 < a_1 < a_2 < \cdots$ be an infinite sequence of positive integers. Prove that there is a unique integer $n \geq 1$ such that

$$a_n < \frac{a_0 + a_1 + \cdots + a_n}{n} \leq a_{n+1}.$$

Problem 2 Let $n \geq 2$ be an integer. Consider an $n \times n$ chessboard consisting of n^2 unit squares. A configuration of n rooks on this board is *peaceful* if every row and every column contains exactly one rook. Find the greatest positive integer k such that, for each peaceful configuration of n rooks, there is a $k \times k$ square which does not contain a rook on any of its k^2 unit squares.

Problem 3 Convex quadrilateral $ABCD$ has $\angle ABC = \angle CDA = 90^\circ$. Point H is the foot of the perpendicular from A to BD. Points S and T lie on the sides AB and AD, respectively, such that H is inside triangle SCT and

$$\angle CHS - \angle CSB = 90^\circ, \quad \angle THC - \angle DTC = 90^\circ.$$

Prove that line BD is tangent to the circumcircle of triangle TSH.

Day 2

Problem 4 Points P and Q lie on side BC of acute-angled triangle ABC so that $\angle PAB = \angle BCA$ and $\angle CAQ = \angle ABC$. Points M and N lie on lines AP and AQ, respectively, such that P is the midpoint of AM, and Q is the midpoint of AN. Prove that lines BM and CN intersect on the circumcircle of triangle ABC.

Problem 5 For each positive integer n, the Bank of Cape Town issues coins of denomination $\frac{1}{n}$. Given a finite collection of such coins (of not necessarily different denominations) with total value at most $99 + \frac{1}{2}$, prove that it is possible to split the collection into 100 or fewer groups, such that each group has total value at most 1.

Problem 6 A set of lines in the plane is in *general position* if no two are parallel and no three pass through the same point. A finite set of lines in general position cuts the plane into regions, some of which have finite area; we call these its *finite regions*. Prove that for all sufficiently large n, in any set of n lines in general position, it is possible to colour at least $\sqrt{n}$ of the lines blue in such a way that none of its finite regions has a completely blue boundary.

Note: Results with $\sqrt{n}$ replaced by $c\sqrt{n}$ will be awarded points depending on the value of the constant c.

Note: (not in the original) the word finite has been inserted as the second word of the second sentence of Problem 6 for reasons of mathematical integrity.

These questions were submitted to the IMO by Austria, Croatia, Iran, Georgia, Luxembourg and Austria respectively. The American juror Po-Shen Loh suggested this modified statement of Problem 6.

Forthcoming International Events

This is a summary of the events which are relevant for the UK. Of course there are many other competitions going on in other parts of the world.

The next few IMOs will be held in Thailand 2015, Hong Kong 2016, Brazil 2017, Romania 2018 and the United Kingdom 2019. Forthcoming editions of the European Girls' Mathematical Olympiad will be in Belarus 2015, Country X in 2016 and Country Y in 2017. In fact matters are far more advanced than this cryptic list suggests, and EGMO is unlikely to need a new host country until 2018. The Balkan Mathematical Olympiad will be held in Greece in 2015, and the Romanian Master of Mathematics will be in business again in 2015, now with the Romanian Mathematical Society deeply involved.

Diary

This diary is a facetious summary of my personal experience at the IMO, and is not necessarily fair, balanced or accurate. Bits of it are. Note that Joseph Myers will appear from time to time in the sequel. He is a long-time UKMT activist who volunteered to help with co-ordination in South Africa at short notice when

someone had to pull out. He clearly enjoyed the experience immensely. He feels most at home when working with people who have at least two times as many gold medals as himself.

June 29th

I start from Bath. The new pastoral specialist, our Observer C, is Jill Parker. She brought up three diverse but excellent sons, and so looking after the six UK lads should be easy enough. Sorry, the UK has an all male team again, but at least we sent four British girls to the excellent European Girls' MO in Turkey in April. An incomprehensible UK Egmoid 2014 report is available via Joseph Myers's IMO register, together with documents which make considerably more sense.

`http://www.imo-register.org.uk/reports.html`

Unless you were actually there, the Egmoid report might as well be written in *Linear A*. There will be a crackdown of awesome brutality, and henceforth British student reports will be fewer in number, and will be less infused with *magic realism*.

Jill and I travel to Heathrow by train and bus, and arrive in good time despite the best efforts of British drivers to slow us up by crashing their cars on the motorway. Our party assembles in Terminal 5, and items of clothing are distributed. There are some very natty quartered sports shirts, but unfortunately not in my size. Dominic is responsible, if that is the word, for the uniform, and he has selected some virulent lime green shirts in an effort to confine the wearing of mathematical clothing to the actual competition. All items are emblazoned with the name of our generous sponsors, *Oxford Asset Management*. Anyway, my ersatz DayGlo shirt will enable me to attract the chair's eye in jury meetings.

Freddie Illingworth burst on the competitions scene last year with a gold medal in the abnormally late Balkan Mathematical Olympiad in 2013. It is extremely likely that he would have been in the UK team for the Romanian Master of Mathematics in 2014 had it not been cancelled, and this remark applies to some other UK team members of course. Freddie was a reserve for the IMO team of 2013.

Joe Benton's international debut was in the Balkan MO 2014 in Bulgaria where he obtained a bronze medal. Joe will have three more chances to compete in IMOs.

Harvey Yau is our youngest and most Welsh contestant. He made his debut in Bulgaria this year, obtaining a bronze medal. The maths competition community have been aware of Harvey for a long time, and we have been waiting for him to become old enough that we could reasonably take him to an overseas competition without risk of attracting the attention of the social services. He first reached the

BMO2, the final round of our national mathematical olympiad, two years ago. He will have four more opportunities to compete in IMOs.

Warren Li is our Yorkshireman. His debut was in the Romanian Master of Mathematics in 2013 where he secured a bronze medal, and he won another bronze in the Balkan Mathematical Olympiad later that year held in Cyprus, and a silver medal in IMO 2013 in Colombia. He won a bronze medal in the Romanian Master of Mathematics in 2013.

Frank Han has the Chinese name Zhenyu. He is being educated at a boarding school in the UK. His debut was also in the Balkan Mathematical Olympiad in Cyprus in 2013 where he won a silver medal. He was a reserve for IMO 2013 in Colombia.

Gabriel Gendler won a bronze medal in the Balkan Mathematical Olympiad of 2012 in Turkey. He was a reserve for IMO 2012 in Argentina, and secured an Honourable Mention at the Romanian Master of Mathematics in 2013. He won a silver medal at IMO 2013 in Colombia.

The flight from Heathrow to Cape Town is a single hop on British Airways. I have acquired a wrap-around travel pillow to assist sleeping, but unfortunately it is designed for Keira Knightley, rather than for Geoff Smith or a *Sontaran warrior*, and it renders breathing difficult.

June 30th

We arrive at Cape Town Airport at breakfast time. The Australians have beaten us by a few minutes, and the efficient IMO greeters have already sent them off to our common base, the *Little Scotia*. This is an excellent boutique hotel, close to the University of Cape Town campus. The setting is delightful. You look uphill to see the campus, then the Cecil Rhodes Memorial, and finally the extraordinary Table Mountain. This must be one of the most dramatically placed universities in the world.

The Little Scotia is a friendly place, and is guarded by giant dogs. It is July, and therefore midwinter, and so the nights are little chilly. However, the IMO organizers have warned us very well, and those of us (e.g. me) too stupid to pay heed to this information have only ourselves to blame.

We soon find the Australians, who make us cups of tea. We all visit the *Hussar* steak house at the end of the street, and discover that restaurants in South Africa are very cheap by European standards, and the quality is often excellent. The Hussar offers a menagerie based menu, and might form the basis for another David Attenborough BBC series: *Mammals on a Plate*. Carnivorous readers yet to sample a Kudu steak should do so as soon as possible.

In the evening we find a Thai restaurant which allows you to tune the level of seasoning of dishes on the scale mild, medium, hot and Thai. Their Thai level *Tom Yum Gai* straddles the divide between delicious and the threshold of pain, like a Turkish Bath for your insides.

It is quite cold that night, and I keep warm by huddling under the blankets and thinking about Tom Yum Gai.

July 1st

The first Australia versus UK exam is held in the morning. I visit the exam site by means of the campus bus service called the Jammie shuttle. The IMO Director John Webb is storing a large number of packs of UKMT branded playing cards in his office. We have had problems with customs authorities when having IMO gifts delivered from the UK. We sidestepped this problem by having these packs printed in South Africa, and then using Prof Webb's office as a storage facility.

The Jammie Shuttle bus service is pronounced like the popular biscuit, the Jammie Dodger. It is named for the controversial colonial statesman and drummer, Leander Starr Jameson, rumoured (but only by me) to be the great-grandfather of Ringo. Jameson Hall is the site of both opening and closing ceremonies of IMO 2014.

The upper campus has two bus stops facing one another. Having arrived at one, I try to depart using the other, using my extensive experience of two-way roads. After four buses drive past the other way, it becomes evident that the Jammie Shuttle is not really a shuttle at all, but a Jammie circular, and the second bus stop is just put there to waste the time of first-time campus visitors.

In the afternoon I assist Dominic with the marking, and happily the UK students do quite well. The Australians have Alex Gunning on their team. He has become so good at IMO mathematics that no-one can remember the last time he lost a mark on a practice paper. The forthcoming Maths Ashes looks daunting with Alex on the Australian side.

In the afternoon I recognize Gordon Lessells walking past my room, together with the Irish team. One of their side is the popular Luke Gardiner who has been training with the British students a couple of times during the year. Where you find the Irish, expect to find Trinidad and Tobago close at hand, and I know that we can expect a Caribbean presence in the hotel soon.

In the evening I notice something in my eye, and decide not to worry about it.

July 2nd

John Webb picks me up in the morning, and I expect to transfer to the teacher training college in the country which I had been told was the leaders' site. It turns out that there has been a change of plan, and that instead the leaders will stay at a hotel on the other side of Table Mountain. Thus security will be provided by the mountain itself, and its savage little inhabitants called Rock Hyraxes (Hyraces?) which are related to elephants and dugongs. In case anyone tries to go round

the mountain rather than over it, the muggers of Cape Town are standing by to impose stiff penalties.

There are very few leaders at the hotel when we arrive, so I decide to worry about my vision. The reception people of the *Garden Court Hotel* kindly arrange a telephone call with their tame doctor. I describe my symptom, and ask if I can wait until I get back to the UK to sort out the black object in my right eye, or whether I should seek attention immediately. He is extremely clear about the need for haste, and I go into controlled panic mode. As Joseph Myers sails in, I am issued with a minder in the form of Phil Labuschagne. He drives me to the Cape Town Medi-clinic, and stays with me for an hour or two while they do the preamble. We spend a happy time filling out forms and having my blood-pressure taken, until finally the nurse says that Dr Donelly will try to fit me in. At this point I decide that poor Phil should be released, and he returns to the IMO.

I get a dose of astringent to dilate the pupil of my right eye and wait to be seen. In fact it doesn't take too long. Dr Donelly is admirably robust, and begins by enumerating possible causes for my symptom. It is like a list of possible prizes in an unlucky-dip. Everyone gets to win one, but you don't know which it will be. There are a few things on the list which I think I might skip (don't worry, we could easily sort that out with laser surgery), and finally he comes to the least interesting but in every way the most attractive option of a very large floater in the vitreous humour. Having set the stage for the forthcoming drama, he then bends forward and has me perform the dance of the eyeballs while he peers and considers. He quickly determined that it was only a floater, and that there no serious threat to my vision. Thank you for a job well done Dr Donelly.

I return to the IMO leaders' site by taxi, and by now the building is starting to fill up with leaders, co-ordinators (marking police) and organizers. I have a copy of the shortlist, and life doesn't get much better than this.

July 3rd

This is the normal day for leaders to arrive, but I spend most of it in conclave with the other members of the IMO Advisory Board. We talk a lot, and make some good decisions, and listen to a presentation from Thailand about their plans for IMO 2015. I am intimidated. At one point I present the offer to host IMO 2019 in the UK, and then withdraw from the meeting while the matter is discussed. Happily, for me and my dear friends in the UK Maths Trust, the IMO AB decides to recommend to the jury that the offer be accepted. So, just the one more hurdle to go, my presentation at the final jury meeting.

We consider various matters concerning IMO policy, and the development of the IMO Foundation. Mike Clapper explains the progress that has been made during the year.

July 4th

Many leaders work on the problems, but there is some introductory jury business. I have noticed that in the shortlist, $G1$ surrenders to a short areal calculation, and point this out to the jury. I supply the proof to the co-ordinators, who promptly and sensibly request a tutorial on areal (barycentric) methods. Various problems are turfed out by the jury in the next couple of days for being too close to problems which have been used before.

There is a debate on the problem selection protocol. Last year we introduced a new one, designed (by me) to ensure that problems 1, 2, 4 and 5 all come from different areas of mathematics. There is substantial support for this protocol, but it will be tested nearly to destruction by the shortlist of IMO 2014. The difficulty is that the shortlist has 9 official combinatorics problems on it, and additionally many of the problems in both the algebra and number theory sections are clearly combinatorics problems dressed up to look like something else.

This problem is compounded when the jury sets about ejecting some genuine algebra and number theory problems on grounds of prior art, so we are left with geometry problems, and a sea of combinatorics. Unsurprisingly, we find ourselves in difficulty when constructing a paper. Some people claim that this is a shortcoming of the 2013 protocol, but in my view this is nonsense. We have a defective and unbalanced shortlist, and no voting protocol can remedy that situation by magic.

There are people who do not like the 2013 protocol for a specific geometric reason. Some people want two geometry problems at each IMO, and would like them to be one easy, and one medium. For people who love geometry, this does look very attractive, but it would have the consequence that at least one of the four IMO subject areas would not appear in an easy or medium position in such an IMO. My judgement is that there are more jurors who are concerned to have a balanced set of accessible questions than there are jurors who are determined to have two accessible geometry problems on each IMO.

Anyway, this is up to the jury to decide. The 2013 protocol does what it says on the tin. You get a balanced paper, and that means at most one geometry problem in the easy and medium positions. If the jury wishes to have two geometry problems on the paper, then if using the 2013 protocol, it follows that one of them must be a problem 3 or a problem 6. This is the real matter at issue.

The excellent jury chair Dr Sizwe Mabizela has a genial manner, and likes to begin jury meetings with a homily related to the World Cup. In the evening he reflected on the passage of Germany through to the semi-finals.

July 5th

In the morning, Sizwe Mabizela's "thought for the day" concerns the progress of Brazil at the World Cup.

The jury is using the 2013 voting protocol for the second time, and we choose the paper in the afternoon. Problem 6 has been modified to introduce a constant c, and points will be awarded according to the value of c which is attained. Since this is a new departure for the IMO, I can see that the wording is going to be hotly contested.

At length the results of the *Mathematics Ashes* appear on the internet, and Joseph Myers briefs me with the results. Unfortunately the UK has won. Again. Presumably our students have slipped a sedative into Alex Gunning's breakfast cereal to even things up a bit. I find the Australian leader Angelo di Pasquale, and helpfully offer to set up some kind of mathematics training system for Australian students.

After dinner, the English language committee meets with the usual suspects as prominent as ever. The wording of Problem 5 is a nightmare. Must coins in a pile all have the same value? Must coins in a pile all have different values? We invent the notion of the Bank of Cape Town and strive to be as precise as we can. By 10pm local time, five questions are done, and I have had enough of trying to referee this bunch of over-educated pedants, and even more importantly, the Netherlands are about to play Costa Rica in the World Cup. I cede the chair to Po-Shen Loh (who dreamed up this "points for the value of c" business) and suggest that as the expert in the question, he should chair the meeting. I stroll happily towards the bar and the television, whispering to the committee that they should not allow him to mess around with the spelling of the word "colour".

July 6th

This morning I present the work of the English Language Committee to the jury. We get through the first five problems quickly and without incident, but I can see the linguistic vultures circling over Problem 6, so when we get there I ask Po-Shen to take over the presentation, and return to my seat to enjoy the bloodbath. After about three hours of debate, the jury eventually decides that the original ELC wording was optimal. This is normal jury behaviour.

Now the jurors get down to serious work, translating the problems into the other 53 language versions, sometimes via the translations of the other official IMO languages: French, German, Russian and Spanish. In the evening the jury ignores requests to revisit the original wording of problem 6 on the ground that we have a competition to run.

July 7th

Marking schemes are presented by the extremely intelligent and co-operative co-ordinators. The jury recommends some changes and these are adopted. The opening ceremony is scheduled for 17:00. The leaders are dropped next to the Rhodes memorial on campus. Cecil Rhodes is another person about whom it is

possible to hold more than one opinion. He donated the land on which UCT is situated, with the proviso that it had to be used for a university. Nice one Cecil. That stuff about colouring the map pink goes down less well.

We are in great danger of meeting contestants, and that is not allowed because we know the papers. South African heavies in green blazers usher us into a holding pen in the maths department, and I have a very happy time chatting with the delegation from India.

Eventually we are allowed in to Jameson Hall. The ceremony begins with a moving rendition of *Nkosi Sikelel' iAfrika* in its modern form, with passages in Xhosa, Zulu, Sesotho, Afrikaans and English. There is a great deal of drumming, presumably to honour the connection with Ringo, and some excellent dancing and clicking of fingers.

The UCT Vice-Chancellor Max Price gave a splendid welcome speech, and Nazar later finished the event with a few well-chosen words. In between I was protected by recently developed auditory technology which is a synthesis of Zaphod Beeblebrox's *Joo Janta 200 Super-Chromatic Peril Sensitive Sunglasses* and the *Babel fish*. This enables me to not hear things (in any language) which I might not have found interesting.

The parade of nations is splendid. It is cleverly organized, with extant countries appearing in the order of their first participation. Thus the UK appears quite early as one of the class of 1967. The team is beautifully dressed. Joe Benton has taken over from Sahl Khan as the person on Gabriel's shoulders, and the union flag streams from Joe's back. The UK team hurl vast numbers of sweets at the audience.

Half way through the parade it is South Africa's turn, but they break the procession, and have a splendid special section for the host nation. When the parade resumes, we see the 1990s realignment of geopolitics reflected in new nations participating in the IMO. Finally, the last few countries are from Africa. It is magnificent.

July 8th

Today is the first day of the contest, and the students are allowed to ask questions of clarification for the first 30 minutes. Normally this is a mess, and the local organizers get things working for the next day. However, the local organizers have had a practice run, to make sure that everything will work smoothly. In a triumph of reality over planning, it is a disaster. Something somewhere is not plugged in, or possibly the internet connection is using semaphore to get over Table Mountain. We spend much of the morning answering questions. When it is eventually over, people are seriously discussing using the internal combustion engine as the communications device on day 2. It is only a 10 minute drive round the mountain to the exam site.

Now is the time scheduled for the IMOAB elections, but since it is just before

lunch, we just have the election for Chair. Nazar and I keep the speeches short and light. We are off to the Botanical Gardens for lunch, and while everyone boards the buses, the votes are quickly counted but kept secret. The result is announced at lunch, and it is very close. I have won, but if just a handful of people had voted the other way, Nazar would have won. Of course we remain excellent friends.

There is some horseplay among the more immature leaders, and an African-style crown is placed on my head and photographs are taken. There are pictures on the internet. Angelo di Pasquale, team leader of Australia, attempts to shake my hand. This is, of course, inappropriate, and I offer him the back of my hand for the normal osculatory supplication, but I notice that he is unenthusiastic.

We complete our journey with a visit to the big Cecil Rhodes memorial on the side of Table Mountain. The word ostentatious is an understatement. We manage to use its steps to get a group photo, also available on the internet.

In the evening we have an election for the other members of the IMO Advisory Board, and this results in a surprisingly close contest. The new IMO AB is at `http://www.imo-official.org/advisory.aspx`

July 9th

Contest Day 2 As usual, the communications difficulties have been sorted out, and the Question and Answer session for day 2 is smooth.

We transfer to the students' site by bus, and this is another opportunity for suboptimal procedure. The road map of the UCT campus is complex, and my driver's strategy is try to find the leaders' hall by means of a random drive. We take three tours round the campus until we are dropped near the students' hall. The leaders have foolishly not memorized the halls in which they are staying, despite the fact that they had been occasionally projected onto the video screens at the other site. Most leaders head pointlessly towards the students' hall, but I go the other way (a useful tip at IMOs) into Baxter Hall. This is not correct either, but it is not completely incorrect, and I am rewarded with a water bottle and a woollen hat. I then make my way to Graça Machel hall where I am staying, thereby beating the pack.

I have told John Webb about the chronic knee pain which I suffer bravely and without complaint, so it comes as no surprise that he has arranged for me to have a room on the top floor of Graça Machel hall, with no lift. I return to reception and arrange for a change of room. I bump into the Hungarian leader József Pelikán, and he shares my delight in the mountainous setting, and the amusingly steep slopes. Like me, József is in excellent physical condition, so we play some games of leapfrog in the hotel car park. There are cartwheels and handstands. What joy it is to be alive!

It is a delight to see the UK students again, and to catch up with Dominic and Jill and listen to their experiences.

There was supposed to be a video screen supplying information to the leaders, but it was not to be found in the leaders' residence hall. The method of disseminating official information was therefore a curious mixture of gossip and osmosis. The leaders know that co-ordination is next day, but have only a hazy idea of where it will be. Rumours spread that it was in a building called "Kramer". At first it seemed that we had no map, but I learned that if you prized open your lanyard, hidden inside was an incorrect map of the layout of the campus at an inappropriate scale. The word in the dining room was that you could cross the big scary road between us and the Kramer building by means of a pedestrian bridge. Said bridge did not appear on the map. I asked Graça Machel folk to explain the route, and they told me to go via the footbridge. I explained that I was troubled by the lack of a footbridge on the map. They then explained an alternative and much longer route which did not go via the footbridge. I observed that since they were clearly of the opinion that the bridge existed, it would be more helpful to tell me where the bridge was, rather than tell me where it wasn't. Both parties clearly thought the other mad, and we quietly terminated the conversation.

Dominic and I shared the co-ordinating load. Our students had done little on the hard questions, but scored very well on the easy questions, and had mixed performances on the medium problems.

We heard that one of our students was unwell, so Jill and Dominic went into pastoral overdrive. At one point an ambulance would be called, but in the event no transfer to hospital was necessary.

July 10th & 11th

Co-ordination went quite well. I made sure that our rich harvest of marks on problems 1 and 4 was safe, and picked up a scrap on Problem 3. Dominic worked hard to understand and make good cases for the marks on the medium problems. He did a fine job, and we completed co-ordination very amicably. There had been an issue with Problem 2 for a while, where a UK student had solved the problem correctly (with an agreed 2 point flaw), but had then simply written down the wrong formula. Dominic felt that it would be unjust to punish this, and we were in an unlikely alliance with France who had a student who had solved the problem completely, but did not describe the answer by means of a formula. In the end, the problem captain sorted it out to our mutual satisfaction.

In the evening of July 11th there was a jury meeting. An intruder was ejected. First there was the joint meeting of the IMO Advisory Board and the jury. Mike Clapper explained about the progress with the IMO Foundation. Rachaya Srisurichan presented her plans for IMO 2015, and the facilities looked so attractive that the jury burst spontaneously into flames or possibly applause. I presented the offer to host IMO 2019 in the UK. This was accepted, but I think that if the jury had a free choice, they would have IMO Thailand every year.

After the joint IMOAB and jury meeting, we focus on the serious matter at

hand, the setting of medal boundaries. I was not completely impressed by the levels of disinterest in some of the speeches advocating particular distributions of thresholds. I would not be surprised if there were some procedural changes next year.

When the smoke clears, our own narrow concern is that we have four silver medals and two bronze medals. Dominic, Jill and I are extremely pleased with this performance, since our lowest score is 20/42. Moreover, the three highest scores are from our three youngest students. They can usefully spend the winter trying to close the gap on Alex Gunning for the Mathematical Ashes just before IMO 2015.

Our Irish colleague Luke Gardiner has just missed a bronze medal, and has the rare distinction of a double honourable mention, having solved two problems completely, but not won a medal. Fortunately Luke has another chance next year.

We still have one UK student who is indisposed, so our attempts to celebrate the results are a little muted.

July 12th

Today is the major IMO excursion. I am the sole UK person to arrive on time. An outing to a shopping mall is not ideal, but the infrastructure simply would not support a whole IMO visiting either Table Mountain or Robben Island simultaneously. The V&A Waterfront contains various delights, including a museum of rugby. There is a harbour, and so I go on a boat trip. There are over 1000 harbour seals, and when I see over-quota fish being thrown into the water, it becomes clear what sustains this huge population. There are other treats, such as a Ferris wheel and an aquarium. I have a slow lunch with the Romanian leader Radu Gologan, and we solve many of the world's problems, at least those connected with mathematics competitions. Radu is being extremely helpful regarding plans for future editions of EGMO.

I study the helicopter rides on offer. For a serious amount of money you can go on a 20 minute ride around Table Mountain. However, for a stupid amount of money you can take a genuine Vietnam War era US army surplus Huey helicopter, and enjoy a simulated combat mission screaming low over the trees on the west coast. I see that commercial possibilities are being missed here. It should be that for a ridiculous amount of money you can use the Huey copter to search rural South Africa for big game. You would then strafe a kudu, land the chopper close by, and the crew would get the barbecue going while you had a profound discussions with the *sommelier*.

Eventually Dominic and the walking members of the UK IMO team show up, and experience what passes for fast food in South Africa. *Hint: restaurants are quicker.*

In the evening we have the closing ceremony. This initially involves being locked out of Jameson Hall while listening to, or perhaps feeling, a drumming

exhibition. At last we are allowed in, and the other members of the IMOAB all promptly sit in the wrong place. The head of protocol looks worried, and I negotiate a deal whereby Nazar stays where he is, and the rest of us move to the end of the front row. This puts us in a place where the sound system is not really functioning. We can follow the music, but speech is completely mangled.

Students from all over the world collect their medals, and our silver medallist Gabriel Gendler carefully steps out of line to get his gong from me.

When the ceremony is over, we follow a train of fires to find the reception, generously equipped to address my needs. The leader of Venezuela, Rafael Sánchez, is the chair of the Microphone d'Or committee, which enumerates jury interventions and awards a trophy to the most frequent speaker. Note that this a scientific process, and is completely linguametric. No arbitrary personal judgements concerning quality or intelligence are involved. It is only quantity which matters. I win again, following my earlier triumphs in Slovenia 2006 and Germany 2009, and am presented with a culturally appropriate golden vuvuzela. The party continues, and Frank Han is looking very well refreshed.

Harvey, Jill and I seek an early exit via the unannounced and unexplained late night bus shuttle. We ask for local help and are sent in exactly the wrong direction. We are very pleased to get back to our residences in the end. Dominic sweeps up the rest, and they return soon after.

July 13th

Dominic and Frank Han have non-standard flights out of the IMO, and they leave in the morning. The balance of the party, including Joseph Myers, have a flight home in the evening, so we spend a gentle day doing very little, and this is most welcome. Our indisposed student is now disposed. In the late afternoon we transfer to the airport, and have a relaxed journey home. For once I manage to sleep on the plane, something I can rarely do in cattle class.

July 14th

When leaving the aircraft at Heathrow, Joseph and Jill manage to pass the main group while we are waiting for them, and our more socially incontinent students prove elusive at baggage collection. However, we are soon reunited, and have a certificate presentation ceremony in the arrivals hall.

Girls

The UKMT effort to promote interest in maths competitions amongst girls continues. It is pleasing to observe that many female IMO 2014 medallists, including the unique girl to win a gold medal, Michelle Sweering of the Netherlands, were

former EGMO medallists. Two medal winners in the Ukrainian IMO team were members of their triumphant EGMO 2014 team in Antalya, Turkey.

We now have a dedicated girls' summer camp in Oxford to supplement our other camps, and a talent search exam, the UK *Mathematical Olympiad for Girls* to try to locate promising female students. I urge other nations to develop their own structures with a similar purpose.

Acknowledgements

There is a vast competitions, mentoring, camps and publications apparatus which underpins the IMO team. Almost all young mathematicians in our country make contact with UKMT via the excellent Mathematics Challenges which form the heart of our national effort. These Challenges are the foundation of a structure which tries to stimulate, develop and encourage enthusiastic young mathematicians, both inside and outside the classroom. I pay tribute to everyone involved in helping to make this possible: the hundreds of UKMT volunteers, the small band of professional UKMT administrators, and the families whose lives we disrupt with our camps and competitions.

Dominic Yeo was a brilliant deputy leader, and our observer Jill Parker managed our crises with discretion and calm aplomb. Many thanks to them both. It was also a pleasure to have Joseph Myers around, though he was not part of the UK delegation.

The team acquitted themselves perfectly throughout, both mathematically and in terms of behaviour, and it has been a pleasure to work with them. The reserves were all splendid.

I must specifically thank *Oxford Asset Management* for their generous sponsorship of the UK IMO team, and the other donors, both individual and corporate, who give so generously. Why not join in?

`http://www.ukmt.org.uk/about-us/`

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