Summer Conference the Tournament of Towns 2013

Olga Zaitseva, *(University of Toronto)*

The Tournament of Towns is an international mathematics competition first held in Russia 35 years ago. It was founded by Nikolay Konstantinov, a prominent Russian educator and mathematician, who wanted to create a new kind of contest based on the best traditions of the USSR Olympiads, with unique features of its own. The most important feature of the Tournament is a focus on research in mathematics.

Students from all over the world take the Tournament at places close to their homes, and the top scorers are invited to attend a Summer Conference featuring a more intense research experience. Every year the Jury, a team of several enthusiasts, world class mathematicians create new topics of exploration. Under their guidance the participants immerse themselves into current streams of mathematical research through problem solving.

This year, two tenth grade Toronto students accepted the invitation to attend the conference: Dima Paramonov and Sina Abbasi.

They were accompanied by Jonathan Zung, a third year University of Toronto student and former conference participant who would be working on the jury, and also by the author, who is president of the Tournament of Towns local committee. This was my eleventh trip to the Summer Conference as a supervisor of the Toronto group which in some years also included participants from Windsor and Edmonton.

Our trip to Belarus began on the morning of August 1. Parents, with tears in their eyes, hugged their kids one last time. Our flight involved two layovers, delays, sleepless nights, and passing through numerous official controls, but the young participants did not complain. As entertainment while stuck at airports, they solved math problems. When we finally arrived in the airport at Minsk, a representative of the Zhemchuzhina Rehabilitation Centre was waiting, ready to drive us two and a half hours to the conference site. As we approached this picturesque area near the Lepel forest reserve, we were greeted with genuine hospitality by the local personnel. It somehow seemed right that the name of the place we were visiting (Zhemchuzhina) was the Russian word for "gemstone.''

The next day, still adjusting to the seven hour time zone difference, we took a walk in vicinity of the centre. Belarus is a country of forests, thousands of lakes, and agricultural fields where wheat and potatoes traditionally produce good crops. The nature is peaceful with an elegant beauty of central Europe. The boys may not have fully appreciated the scenery, however – they were deep in thought, discussing a problem Jonathan had suggested.[1]

1 For the problem, see http://math.stackexchange.com/questions/371184/predicting-real-numbers

By dinnertime, the team had solved the problem and was busy working on a new one. Meanwhile, additional teams were coming in from Germany, Iran, and Croatia. Finally, a large group including Russians, Serbians, Ukrainians, and Kazakhs arrived by train from Moscow, and it was time for the conference proper to begin.

At Opening Ceremony Nikolay Konstantinov greeted the participants and outlined the schedule of the conference. This year, the Jury presented five topics for investigations "Brocard points", "Aperiodic tilings", "Halving graphs", "Diophantine equations", and "Realizability of hypergraphs: examples and algorithms".

Each topic consists of a set of problems and theorems which are milestones of investigation. Some of included problems however may not be directly related to the main topic but are of independent interest. Given a large number and variety of problems no individual (or even a team) can excel in solving everything. The task of the Jury is not to compare contribution of teams but evaluate the progress. Often, topics include some open problems and although it rarely happens, there have actually been cases in which contestants have succeeded in solving previously unsolved problems.

Participants can choose to work on any of the Topics. One of the greatest impacts of the Conference is that the participants continue to work on the projects when they are back home.

After reflecting upon the choices for a day, Dima decided to investigate "Aperiodic tilings," while Sina started to work on "Halving graphs." Jonathan joined the jury focusing on the project "Realizability of hypergraphs: examples and algorithms".

It was a new and unique experience for Dima and Sina. Participants worked whenever they had inspiration and energy – there was no officially established time for work. The contestants kept at the problems, taking only short breaks for impromptu volleyball and football games. I would venture a guess that even in their sleep, the problems continued to bounce around in their heads.

In short, I am happy with our guys' work. The boys worked hard and did well. Most of their Russian peers have an advantage in experience. Traditionally, in Russia there are more opportunities for girls and boys with a passion for mathematics: in additional to schools and classes specialized in math there are Math Circles, Winter and three weeks long Summer Math Camps. It is easy to imagine the edge that Russian students can gain through these efforts.

While participants worked hard on their projects, the team leaders attended seminars where we discussed in length our experience working with students in the framework of the Tournament and beyond it.

On August 6, participants submitted to the juries their progress thus far. On the 7th, the Jury presented an account of participants progress, including both solutions to some problems and overviews of the second part of the projects.

The following day, we took a break in the conference routine and walked an hour to Lake Bobritsa. The weather was nice and hot, and it was a welcoming sight as the beautiful wooded lake came into view. In no time at all, everyone was in the water.

As the day progressed, we snacked and had tea from a samovar. Some played volleyball, some went swimming for a second time, and some discussed math problems. Nikolay Konstantinov made an attempt to persuade the participants that a quadratic equation can have three roots[2]. Of course, the participants quickly saw through the trick.

However, the solution of another problem, suggested by Sergey Dorichenko, took longer[3]. Sergey is the main publisher of *Kvantik*, a math journal designed for kids of grades 4–8 (the younger sibling of the famous journal *Kvant*).

We returned invigorated to Zhemchuzhina for a late lunch. The conference continued in its established way.

The evenings were times for socializing, as conference participants gathered near a 25 litre samovar. It is a real copper samovar produced by Tula's master artisans a century ago. Thirty years ago, Konstantinov bought it in Germany and took the trouble to bring it back to Russia. Since then, the samovar has accompanied every TT conference, and a picture of it is the Tournament logo. It takes experience to kindle the samovar and boil the water – everyone tried, some more successfully than others. As we talked and socialized, we learned a lot about life, customs, and education in other countries. Many participants found fast friends. Some evenings we were treated to virtuoso guitar performances by Sergey Dorichenko.

Time flies quickly. Final submission of projects was late in the evening of August 10. By morning, the work had been reviewed by the jury.

I greatly admire by the Jury of the Conference. They are great people, united by idea of bringing new generation of talented mathematicians. Names of Alexey Kanel-Belov, Arkady and Michail Skopenkov, Ilia Bogdanov, Grigory Chelnokov, Alexey Zaslavsky, and Konstantin Kokhas became legends. With passing years the team of the Jury grew. Several young people, former participants of Summer Conferences have now entered the line of seasoned prominent mathematicians and educators. No one of the Jury is paid for the work at the conferences.

On the 11th, students were lectured on their project topics, while organizers hurried to print diplomas and burn CDs with materials and pictures of the conference. In the closing ceremony on the 12th, each participant was presented with a diploma and a large pile of books. Each participant's diploma featured an evaluation of that student's individual work. Possible evaluations included: "achieving a partial advance'', "proving a theorem'', "achieving an essential advance'', and "achieving a maximal advance''.

2 Indeed, consider the equation:
$(a-x)(b-x)/(a-c)(b-c)+(b-x)(c-x)/(b-a)(c-a)+(c-x)(a-x)/(a-b)(c-b)=1$
Then it is easy to see that $x=a$, $x=b$ and $x=c$ are the roots.

3 It is possible to place 100 circles of radius 1 into a given rectangle without overlapping. Is it necessarily possible to place 400 circles of radius 1/2 into the same rectangle? This problem will appear in a future issue of Kvantik, n.8.

As the day progressed, we said our goodbyes to the other teams. New friends exchanged emails and souvenirs of the occasion. Everyone felt sad.

At 2 a.m. we started our 24 hour journey back home. The Summer Conference of 2013 was over.

Results: Sina Abbasi worked on the project "Halving graphs" and achieved an essential advance.

Dima Paramonov worked on "Aperiodic tilings" and also achieved an essential advance.

Jonathan Jung's work with the Jury on the project "Realizability of hypergraphs: examples and algorithms" resulted in an article, "A non-general-position Parity Theorem". The article will be submitted to the arXiv shortly.

These achievements make all us proud.

We are grateful to the Math Department of the University of Toronto and in particular to Kumar Murty, the Chair of the Math Department, who made it possible for our group to travel to the Summer Conference. The trip was well worth the effort and expense. Not all of Summer Conference participants will become professional mathematicians; however, the contribution of talented people with open inquisitive minds will certainly benefit to all of society.

Information about the Summer Conference can be found at: **http://www.turgor.ru/lktg/2013/**