ALOIS STRNAD—LEADING PERSONAGE OF THE I. AND R. MATHEMATICAL OLYMPIAD

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ABSTRACT

This paper deals with Alois Strnad, who was a teacher at Czech secondary schools. His curriculum vitae as well as his scientific and pedagogical publications are mentioned in this contribution. Strnad played a leading role in the running of the mathematical competition organized by the Union of Czech Mathematicians and Physicists. Strnad published more than 500 tasks, which was about one third of all the tasks published between 1872 and 1918. Majority of these tasks were on algebra and geometry and they covered all subject matters taught at secondary schools.

1 Introduction

At the 5th ESU, which took place in 2007 in Prague, I talked about the writing competition that was organized by the Union of Czech Mathematicians and Physicists and published in the *Journal for the Cultivation of Mathematics and Physics* (further in this paper abbreviated as *Journal*). I call this activity *Imperial and Royal Mathematical Olympiad*. Although this is not the official title, I will use it in this article. For the sake simplicity, I will often use it in its short form, *Olympiad*. It was Alois Strnad who, in my opinion, should be given the greatest credit for helping the *Olympiad* survive its critical times after Studnička, the editor-in-chief of the *Journal*, had given up the editorship. After that, there was nobody who could publish enough tasks every year. It was precisely Strnad who took up this job and started to publish dozens of tasks each year till his death. This paper brings some information about Strnad's life and his scientific and pedagogical activities.

2 Curriculum vitae

Alois Strnad was born on the 1st of October 1852 in the Prague district Malá Strana (Little Quarter). He spent his youth in that marvelous part of Prague and here he also studied at Czech reálka[1] in Panská street. After passing the school-leaving examination in 1870 he started to study at Czech Provincial Polytechnical Institute (technical university) in Prague. His study results were always excellent and Strnad was several times awarded prize for them. In winter semester he was appointed assistant to Prof. Tilšer[2] at that school and he taught descriptive geometry. Since 1875, he also gave lectures instead of Prof. Tilšer.

Strnad, however, decided to leave the university career, passed the teacher's exam

[1] Reálka (in German Realschule) was a kind of a secondary school which focused on technical subjects rather than humanities.

[2] František Tilšer (1825–1913), Professor at Czech Provincial Polytechnical Institute.

and in 1876 was appointed professor[3] at reálka in Hradec Králové in eastern Bohemia. At this school he taught for fifteen years, till 1891, when he returned to Prague. For the following five years, he taught at the Czech reálka in Ječná street. His pedagogical career culminated in 1896, when he was appointed director at the reálka in the marvellous old town of Kutná Hora.[4] Strnad led this school for fifteen years, although he had to take leaves for health holiday, because his health got worse. He died on 26th May 1911.

Strnad was a very modest man, he did not struggle for worldly fortune. We can say teaching was the sense of his life. On the other hand he was rather disappointed that he could not devote more time to scientific work owing to his school activities. Despite this, Strnad published about 30 papers, mostly in Czech journals. He is also the author of textbooks and exercise-books for the *Olympiad*. Owing to his contributions to mathematics and its teaching, he was appointed corresponding member of the Czech Academy and honorable member of the Union of Czech Mathematicians and Physicists.

3 Strnad and the Olympiad

In the *Journal for Cultivation of Mathematics and Physics*, volume 13, issue 2, we can find this task: *A cone with radius 15 cm and altitude 30 cm is given. At what height must we cut the cone by a plane parallel with the base so that we can inscribe a sphere into the truncated cone? What is the volume of the truncated cone?* The author of this task was Alois Strnad and except that exercise he published another three tasks in that volume. Maybe nobody supposed that the name of Strnad would be appear at the pages of the Journal every year till 1908, when Strnad published his last task. And nobody anticipated that the signature of Strnad would appear more frequently than the names of all the other authors in the years 1872–1918 together. The total number of exercises published as a part of the Olympiad reached 1351. Strnad published 508 exercises, which means Strnad is the author of about 38 per cent of the total number of published tasks. None of the other authors contributed with an at least comparable number of tasks. I did not considered it necessary to make scale of all authors, so I do not know who would occupy the second position on the scale. However, the man holding the second position, whoever he was, only contributed with several dozens of exercises to the Olympiad. In addition, Strnad started his activity in the Olympiad at the time when organizers were short of tasks suitable for publication. It was just Strnad who every year published dozens of tasks that covered all branches of mathematics taught at grammar schools. We can find there tasks on constructive and analytic geometry, stereometric problems, many kinds of equations, number theory and so on. In some exercises, Strnad asked for a proof of some theorem, especially in geometry. According to my experience, it is really good to occasionally choose some old (not only Strnad's) problems and assign them to students. Contemporary students are usually surprised how excellent their ancestors' knowledge of mathematics was. It is a pity that foreign readers are limited by the fact that the exercises are written in Czech.

It is very difficult to choose a representative selection of Strnad's exercises; what follows is my subjective selection.

[3]Every teacher at secondary school used the title professor, so it is necessary to differentiate between the secondary school professors and professors at universities.

[4]In the middle ages, this town was second biggest in Bohemia and was important because of its silver mines and minting of coins named *Prague grossus*.

1. If n is an integer, then $60|n(n^4+35n^2+24)$. Prove it. (Vol. 25, exercise 1)

2. How many digits does number 777^{777} contain? (Vol. 25, exercise 2)

3. Three mass particles (points) are moving on three given lines in the positive direction. What is the time in which they get to the points A_1, B_1, C_1 forming a triangle of minimal (maximal) area? (Vol. 29, exercise 50).

4. Assess the sum of the series, whose general member is $a_n = (-1)^{n-1}\frac{a^{\frac{m+1}{2}}}{b^{\frac{m-1}{2}}}$, $m = (2n-1)(-1)^{n-1}$. (Vol. 33, exercise 3)

5. Point P and an ellipse are given. Construct a line that crosses the ellipse in two points A, B. To these points construct two associated diameters of the ellipse. (Vol. 36, exercise 37. This is the last exercise which Strnad published in the Olympiad.)

4 Strnad as an author of textbooks

Strnad also wrote three textbooks. Nobody is surprised that Strnad wrote, together with F. Hromádko,[5] *Collection of exercises on algebra*. Strnad was the leading person in publishing this exercise-book and he still improved this book with new exercises. During his life this book was published in seven editions. This work was the first of its kind published in Czech and it was really needed. Strnad did not manage to rework this book according to the new school programme, because when the new programme had been devised, he was already seriously ill. For that reason he passed the copyright to the Union of Czech Mathematicians and Physicists.

Strnad wrote two exercise-books on geometry, namely *Geometry for higher reálka* and *Geometry for higher gymnasium*.[6] Although the titles of these exercises-books are similar, we must consider them as two different works because the school programmes were different at those two kinds of schools. The textbooks covered all branches of geometry taught at secondary schools. It deals with such terms as line, angle, triangle, circle, tetragon, polygon and their equivalency and similarity in planimetry. A section is devoted to stereometry and to reckoning surfaces and volumes of various solids. Trigonometry is both in the plane and on the sphere[7], exercises are mostly intended for practice. Analytic geometry is the last part of these textbooks, and apart from the parts devoted to the line and the plane, we can also find a treatise about conics here.

The textbook on geometry for gymnasium was also translated into Bulgarian. Explaining this fact is really simply. In the second half of 19th century some Czech teachers helped to build secondary educational system in other Slavonic countries. They partly wrote new textbooks and partly translated textbooks used in the Czech lands. For that reason even Strnad's textbook was translated into Bulgarian by professor Šourek[8].

Strnad's textbooks are written in 'Euclid style', i.e. definition, theorem, proof. Strnad proved every theorem. The reader does not find here any example for motivation,

[5] František Hromádko (1831–1911), teacher at Czech grammar schools.

[6] Gymnasium was a kind of secondary school, it gave students universal education.

[7] This part is not taught at Czech grammar schools nowadays.

[8] Antonín Václav Šourek (1857–1926), teacher at various Bulgarian secondary schools and later Professor of mathematics at University in Sofia. Further details in (6).

commentary, nor explanatory text, except historical notes, which are used quite often. Strnad added also examples, with every example solved. Strnad also planned to write a collection of exercises, but owing to his duties as a director and to his illness, he did not manage to finish it. While Strnad's exercises are used by teachers even nowadays, I am not sure contemporary studends would like to learn geometry from Strnad's textbooks.

5 Strnad's scientific papers

Strnad published 32 papers, and a majority of them (19) was published in the *Journal*. Further papers were published in annual bulletins of secondary schools where he taught and in others journals. One paper was published in *Archiv für mathematik* (Grunert-Hope) and one in *Rad jugoslavenske akademiji*. Majority of his papers are devoted to various problems on geometry (triangle, Simson straight line, surface of the cone, construction of a regular seventeen-angle). Other papers deal with various problems in arithmetics and analysis. Strnad was not a world-wide known scientist as some of his contemporaries, but his papers were important especially for students, because they enabled them to learn things that were not taught at schools. In the first published paper (3) Strnad proved the theorem of Moret-Blanc which was published a year ago in a different way. For patriotic reason we demonstrate Strnad's style on another paper.

Lerch in (7) presented the following two formulas:

$$\sum_{\varrho=0}^{[\frac{n}{2}]} \psi(n-\varrho,\varrho) = n \tag{1}$$

$$\sum_{\varrho=0}^{n} \psi(n+\varrho,\varrho) = 2n, \tag{2}$$

where $\psi(\alpha,\beta)$ is a number of divisors of α greater than β.

Lerch developed these formulas from the equation

$$\frac{x}{(1-x^2)} = \sum_{\nu=1}^{\infty} \frac{x^\nu}{(1-x^\nu)(1-x^{\nu+1)}}. \tag{3}$$

From the formula for geometric series, it follows that

$$\frac{x^\nu}{1-x^\nu} = \sum_{\mu=1}^{\infty} x^{\mu\nu}$$

and

$$\frac{1}{1-x^{\nu+1}} = \sum_{\varrho=0}^{\infty} x^{\varrho(\nu+1)}.$$

The equation (3) changes into

$$\sum_{n=1}^{\infty} x^n = \sum_{\mu,\nu\varrho} x^{\mu\nu+\varrho(\nu+1)},$$

where n is a number of the solutions of the equation

$$\mu\nu + \varrho(\nu + 1) = n.$$

Strnad denotes by $\Psi(\alpha, \beta)$ all divisors of α which are greater than β and by $\Psi_{\varrho=0}^{n-1}(n-\varrho, \varrho)$ all divisors of the sequence

$$\Psi(n, 0), \quad \Psi(n-1, 1), \ldots \Psi(1, n-1)$$

He proved that all the members of this sequence form an arithmetic series $1, 2, \ldots, n$ which means Lerch's formula (1) is correct. The equation $n - \varrho = mp$ is solved in integers for every $p > \varrho \geq 0$. It follows from the formula

$$\frac{n}{p} \geq m > \frac{n}{p} - 1.$$

Strnad added also the formula

$$\sum_{\varrho=0}^{n} \Psi(n-\varrho, \varrho) = \frac{n(2n+1)}{2}. \tag{4}$$

In a similar way he proved Lerch's formula (2) and added also the formula

$$\sum_{\varrho=0}^{n} \Psi(n+\varrho, \varrho) = n(2n+1) \tag{5}$$

Lerch's proof of this formula is much longer, so we refer the reader to Lerch's original paper (7). Lerch returned to this problem some years later in paper (8), where he presented additional formulas and quoted Strnad's paper.

Except for normal papers, Strnad published also many so-called Little notes in the *Journal*, in which he made readers familiar with various papers published in foreign journals. Between years 1886–1892 when articles of such kind were published in the *Journal*, Strnad published twenty-one contributions in these columns. In the first Little note Strnad informed the readers that Landy proved that Fermat number F_{26} is not a prime, but a composite. There is a number of such descriptions in one article. Although he was not the only author of such articles, he was again the most hard-working in this activity.[9] This activity proves that Strnad had great knowledge of facts in mathematics and that he was able to reproduce it in an intelligible form. On the other hand, he published several notices about Czech mathematical papers in *Revue trimestrielle des publications mathématiques* and in *Répertoire bibliographique des sciences mathématiques*.

At the end of this section I would like to mention a lovely paper (5), which was published in 1889, on the occasion of the 100th anniversary of The Great French Revolution. Strnad mentioned French mathematicians who played an important role during the revolution. Readers came to know fates of excellent scientists who, apart from their scientific activities, were also leaders of the French revolution. Many lines are devoted to the Organizer of Victory Lazare Carnot, the chief of the parliament Bailly, the favorite of all governments Laplace, a member of Egypt expedition Gaspard Monge, and

[9] Well known scientists as Matyáš Lerch (1860–1922) and Augustin Seydler (1849–1891) also contributed to this column.

so on. Strnad wrote primarily about their life, their scientific results are described only in words and the reader cannot find any formulas in this paper. Other scientists, who did not play so important a role in politics (Legendre, Fourier etc.), are mentioned only shortly. Contrary to Strnads text-books, this paper is written in a nice and eloquent Czech language. It resembles a work of fiction rather than a scientific work. Strnad uses many quotations in French without translation, too, and thus we can presume that the knowledge of French was on a high level at that times, at least in Hradec Králové and its surroundings. This paper is one of the first publications on history of mathematics in the Czech lands.

6 Conclusion

We cannot say Strnad was a world-famous scientists, but we must appreciate him in consequence to the situation in the Czech lands in the second half of 19th century. From this point of view we can appreciate Strnad as a significant personage of Czech scientific and scholastic community. He was an author of textbooks, his papers allowed students to get acquainted with new discoveries in mathematics, and his activity in the Olympiad was essential for continuing this matter. From 1884 till 1904 he was the editor for geometry in the *Journal*. Strnad contributed to *Otto's Encyclopedia*[10], he is the author of about 70 entries mostly on geometry and of the curriculum vitae of Professor Tilscher. We cannot overlook his educational activities. Strnad has his place in the history of Czech mathematics and his heritage is still alive, especially in the educational area. We should not forget this personality, although one hundred years elapsed since his death.

REFERENCES

1. Časopis pro pěstování mathematiky a fysiky, vols. 13–37.
   Available in `http://dml.cz/handle/10338.dmlcz/133460`
2. Jan Sobotka: Alois Strnad (obituary). In Časopis pro pěstování mathematiky a fysiky, vol. 41 (1912), p. 552–557
3. Alois Strnad: Obecná poučka o funkcích (Common theorem on functions) In Časopis pro pěstování mathematiky a fysiky, vol. 2 (1873), p. 142–143
4. Alois Strnad: Čtyry věty arithmetické. (Four arithmetic theorems) In Časopis pro pěstování mathematiky a fysiky, vol. 17 (1888), p. 204–207.
5. Alois Strnad: Mathematikové ve francouzské revoluci (Mathematicians in French Revolution). In Annual reports of reálka in Hradec Králové, 1889
6. Martina Bečvářová: České kořeny bulharské matematiky. (Czech roots of Bulgarian mathematics). Edition History of mathematics, vol. 40. Matfyzpress Praha, 2009
7. Matyáš Lerch: Deux théorèmes d'arithmétique. Bulletin de la Société roayale des Scientes de Bohéme. Praque 1887, p. 682–688.
8. Matyáš Lerch: Sur quelques théorèmes d'arithmétique. Bulletin de la Société roayale des Scientes de Bohéme. Praque 1894, p. 1–17.

[10]This excellent and, in the author's opinion, up to the present days unsurpassed, encyclopedia in Czech countries, has 28 volumes. It has been named after its publisher.