Stjepan (Esteban) Horvat

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Stjepan Horvat was a patriot, a scientist and a professor, dean of the Technical Faculty in Zagreb, head of the Croatian University, editor of the periodicals Geodetski list and Hrvatska državna izmjera, manager of the Department for State Survey in the Croatian Headquarters for Public Affairs, a member of the State Land Consolidation Commission, a member of examination boards, colonel in the time of the Independent State of Croatia (NDH), adviser at the Military and Geographic Institute in Argentina for forty years. His main interests include geodesy, especially the application of mathematics in geodesy and cartography, geodetic astronomy and geophysics, but he also wrote poems, composed and conducted …

Due to the objective circumstances, there has been no complete bibliography of Stjepan Horvat made so far. This paper offers the presentation of my research and the insight into his scientific and professional work.

1. Short curriculum vitae

Stjepan Horvat was born on 29th November, 1895 in Srijemski Karlovci, and died on 12th March 1985 in Buenos Aires in Argentina. He attended classics-program gymnasium in his birthplace, and graduated in Vinkovci in 1915. The same year he entered the Geodetic Course in Zagreb, where he passed geodetic state exam in 1918 and in 1919 a rigorous practical exam for civil practice organised by the State Government. In 1936 he made his degree finals at the Geodetic and Rural-engineering Department of the Technical Faculty in Zagreb.

In June1919 he started to work as a surveying clerk in cadastral surveying office in Zagreb. In October 1920 he went to the Military and Geographic Institute in Belgrade as a second lieutenant of engineering and technical profession, where he worked as a triangulator on setting up and surveying higher order triangulation at the Astronomic and Geodetic Department. In the year 1922 he participated in measuring the base lines of triangulation near Prizren, Prilep and Strumica. He opened a civil geodetic office in Zemun on 1st January, 1923 and took over the surveying of the town Tetovo for the purpose of making regulation base that he finished in 1926.

The same year he went over to the Technical Faculty in Zagreb where he served first on the basis of daily allowance, and then, from the 1st January, 1927 as a contractual clerk at the Chair for Practical Geodesy. In 1930 he became a teacher and lectured the following subjects: State Survey,

Survey and Regulation of Cities, Theory of Errors, Geodetic Computation and Drawing. In 1937 he was appointed an associate professor and a head of the Geodetic Institute, and in 1941 a full professor. In 1943 he was elected dean of the Technical Faculty and head of Croatian University in 1944. At the beginning of May 1945 he had to emigrate. He stayed in Rome in refugee camp Fermo first. He left his university head chain in the Croatian Institute of St. Jeronimo in Rome to be kept there, and it was returned to Croatia only in 1991.

In the Croatian State Archives (Holdings No. 306 of the State Commission for Crime Investigations in 1944-1947, the material of Questionnaire Commission, Box 686, the files marked with ZKRZ-NI 117/45) there are the documents kept from which it is evident that it was suggested to the Zagreb public attorney to arrest Stjepan Horvat on the basis of the *Decision about Investigating Crimes Made by Enemies and their Allies* of 5th July 1945. There is, among other things, the following statement given in the above-mentioned decision: "The accused committed the crime of the blackest dye over our people delivering as a head of Zagreb University a memorandum to the heads of universities and high schools in the "whole world" in which he presented the national liberation fight of our people as a great Serbian conspiracy against Croatian people."

After having spent certain time in refugee camps in Austria and Italy, he went to Argentina in 1948 where he continued his geodetic scientific career as a scientific adviser in Argentinean Military and Geographic Institute (Instituto Geogràfico Militar Argentino – IGMA). At the same time he collaborated with Pan-American Institute for Geography and History, and with the Direction for Geodesy at the Buenos Aires Province. He was retired in 1980, but still active as adviser in IGMA. He was called Esteban, which is the same as Stjepan in Spanish, so Esteban was written in together with the name Stjepan as he received Argentinean citizenship in 1973.

With his scientific and professional articles in the field of geodesy he collaborated in various periodicals: *Zeitschrift für Vermessungswesen* (Stuttgart), *Geodetski i geometarski glasnik* (Beograd), *Zemlemjernoe delo* (Beograd), *Geodetski list* (Zagreb), *Hrvatska državna izmjera* (Zagreb), *Annuario del Instituto Geografico Militar* (Buenos Aires), *Revista Cartografica* (Buenos Aires), *Geoacta* (Buenos Aires) and *Geodesia* (La Plata). He is the author of several scripts and manuals, altogether over hundred scientific and professional works. He wrote a lot about other issues as well (see Macan, 1995).

He was an editor of *Geodetski list* (1937 and 1940), *Hrvatska državna izmjera* in 1942 and *Spomenica 1942-1943 Tehničkog fakulteta* (Commemorative Volume 1942-1943 of the Technical Faculty). His works were presented at the conferences of the International Union of Geophysics and Geodesy (IUGG) in 1954 in Rome and in 1973 in Oxford.

He was an honourable member of the Argentinean Society of Geophysicists and Geodesists from 1979.

He was the father of two sons that were killed in 1945 and of two daughters, Ljubica living in Argentina, and Vjera living in Zagreb.

Kept secret and pushed into oblivion for a long time, Horvat's life and work were finally returned to his people, and in 1994 the Zagreb University Senate paid a due honour to him by putting finally his portrait to the place among other University heads that had been empty till that moment. In November 1995 there was a solemn meeting of the Scientific and Teaching Board held at the Faculty of Geodesy in Zagreb on the occasion of the 100th anniversary of Horvat's birth.

2. References on Stjepan Horvat

There has been very little written about Stjepan Horvat so far. His short biography was published in *Jutarnji list* (Ciprin 1937). There is his curriculum vitae to be found in the Commemorative Volume 1942-1943 of the Technical Faculty (Horvat1943) that was edited by himself, as well as the description of activity field and the list of the work published until then. A short presentation was published in 1944 in the periodical *Plug* on the occasion of his being elected head of the Croatian University.

A few articles dedicated to S. Horvat were published in the periodical *Studia croatica* being issued in Buenos Aires (1975, 1979, 1985).

After that, only in 1992, i.e. seven years after the death of Horvat the articles by F. Braum and V. Farkaš appear in Croatia. T. Macan published in 1995 in *Geodetski list* a text that was read at the solemn meeting of the Zagreb University Senate, and at the solemn meeting of Scientific and Teaching Board of the Faculty of Geodesy, University of Zagreb on the occasion of the 100th anniversary of Horvat's birth.

On the occasion of the above mentioned anniversary the article was published in *Večernji list* (Držić 1995), and there was a seminar paper made at the Faculty of Geodesy (Beber 1996). The presentations of Horvat's manuscript on triangulation adjustment were published in *Geodetski list* (Lapaine, 1996a), as well as of the article from 1940 about trapezium division parallel with its base lines (Lapaine, 1996c). A report has been presented at the First Croatian Congress of Mathematicians (Lapaine, 1996b).

3. Geodetic bibliography of Stjepan Horvat

During the research made within the frame of preparations carried out for the report at the Frst Croatian Congress of Mathematicians (Lapaine 1996b), Marijan Rosenberg has given me as a present a few of the texts written by S. Horvat's hand. Among these manuscripts there is also a list of 38 published papers in Argentina. At the beginning of this list, Horvat wrote himself in red pencil: "Sent to the Academy of Sciences and Arts". Further in the letter delivered in 1967 it reads: "University Library has got so far two of my publications. I am ready to send everything published so far to it, to be collected at one place and kept for someone who might be interested in getting acquainted with my work here."

Above mentioned statements have initiated the idea about checking the data referring to the publications by S. Horvat in some of our libraries. We have checked the library in the Croatian Academy of Sciences and Arts (HAZU), National and University Library (NSK) and the Library of the former Faculty of Architecture, Civil Engineering and Geodesy (AGG Faculty) in Zagreb.

The research has shown that the Library at the AGG Faculty owns *Spomenica 1942.-1943. Tehničkog fakulteta* (Commemorative Volume 1942-1943 of the Technical Faculty) with S. Horvat being its editor and only one more work dealing with the determination of absolute declination of zenith stars from 1942. Apart from that, there is also a bound *Geodetski list* kept in the Library that was published in 1937, 1940 and 1941. Unfortunately, this binding is not complete and it is partly confused.

The HAZU Library has got two books with S. Horvat being their author, but it is not Stjepan Horvat we are dealing with here, but some other Stjepan Horvat – enigmatographer.

NSK has got 14 works by Horvat, three of them published in Argentina. This library has also got a binding of *Geodetski list* that was published in 1937, 1940 and 1941, but it is also not complete. Further, NSK keeps bound *Hrvatska državna izmjera*, a periodical that was published in 1942 with S. Horvat being its chief editor as well.

So far published bibliographies of S. Horvat can be found in *Spomenica 1942.-1943. Tehničkog fakulteta*, Bibliography of the Faculty of Geodesy (1985), the article by F. Braum (1992) and Beber's seminar paper (1996). The text by Macan should also be listed at this place (1995) with a large number of very important and valuable notes. Unifying all that and taking into consideration the donation by M. Rosenberg, bibliographies of *Geodetski list* (Lapaine, Tunjić 1996a), *Hrvatska državna izmjera* (Lapaine, Tunjić 1996b) and *Geometarski i geodetski glasnik* and its predecessors (Tunjić 1996) a bibliography of scientific and professional works by S. Horvat was made clarified and supplemented.

Further in the text there is a list of scientific and professional papers in the field of geodesy published before his leaving Croatia and after it. The papers published in Argentina were written in Argentinean Spanish, and the list gives these titles also translated into Croatian and English. Together with Horvat's works for which we know where they are kept there is also a name of the person and the institution given in brackets. The following abbreviations are used:

GF = Faculty of Geodesy, University of Zagreb

NSK = National and University Library, Zagreb

Publications in the field of geodesy published before his leaving Croatia

1. Najpovoljnija raspodela težina kod pojedinačnog određivanja tačaka uvrštene trigonometričke mreže (The best distribution of weights in the individual point determination of trigonometric network). Spomenica Fakultetskog savjeta, Tehnički fakultet Sveučilišta Kraljevine Jugoslavije u Zagrebu 1919-1929, reprint from Godišnjak Sveučilišta u Zagrebu 1924/25-1928/29, Zagreb 1929, 1042-1080. (M. Lapaine, GF)

2. Geodetske tablice (Geodetic tables), Udruženje studenata Tehničkog fakulteta, Zagreb 1930, pp. 48 (M. Lapaine, GF; NSK)
3. Preračunavanje koordinata u Gauss-Krügerovoj projekciji (Recalculating of coordinates in the Gauss-Krüger map projection). Geometarski glasnik, Beograd 1930, 1, 1-5; 2, 53-59; 4, 139-143 (M. Lapaine, GF).
4. Praktična geodezija, II. deo, Državna izmera I (Practical Geodesy, Land Survey I), Udruženje slušača Tehničkog fakulteta, Zagreb 1931, pp. 209 (M. Lapaine, GF)
5. Praktična geodezija, II. deo, Državna izmera II, (Practical Geodesy, Land Survey II), Udruženje slušača Tehničkog fakulteta, Zagreb 1932, pp. 165 (NSK; M. Lapaine, GF)
6. Osnivanje i izmjera gradova (Founding and surveying of cities), script, Udruženje studenata Tehničkog fakulteta, Zagreb 1932, pp. 108 (NSK)
7. Geodetski instrumenti i mašine za računanje na geodetskoj izložbi 1935. (Geodetic instruments and computers at the geodetic exhibition 1935), Zagreb, pp. 161 (NSK)
8. Neke napomene kod računanja geodetskih koordinata po Clark-ovim formulama (Some remarks on the computations of geodetic coordinates by using Clarke formulas). Geometarski i geodetski glasnik, Beograd 1935, 1, 1-14 (M. Lapaine, GF).
9. Geodetsko računanje, I. Teoretski dio, Osnove teorije pogrešaka i metode najmanjih kvadrata, (Geodetic computation, 1st part, Theory, Elements of the theory of errors and the least squares method), Udruženje slušača Tehničkog fakulteta, Zagreb 1937, pp. 127+3 (NSK; M. Lapaine, GF)
10. Reguljacija stroitel'nyh učastkov (Regulation of building-sites, in Russian), Zemlemernoe delo 1937, sv. 2, 27-41. (NSK; M. Lapaine, GF)
11. Poprečne konformne cilindrične koordinate (Transverse conformal cylindrical coordinates), Geodetski list, Zagreb 1937, 1, 5-21; 1937, 2, 60-72; 1940, 3, 80-88 (NSK; M. Lapaine, GF).
12. Transformation stereographischer Koordinaten (Transformation of stereographic coordinates, in German), Zeitschrift für Vermessungswesen, Stuttgart 1939, Heft 14, 432-437.
13. Neue Formeln zur Bestimmung der rechtwinkligen Koordinaten bei konformer Abbildung der Kugel oder des Ellipsoids auf einen Kegel (New formulas for the determination of the cartesian coordinates in the conformal mapping of the sphere or the ellipsoid onto a cone, in German), Zeitschrift für Vermessungswesen, Stuttgart 1939, Heft 21, 617-627.
14. Precizni poligonski vlakovi s optičkim mjerenjem duljina (Precise traverses with optical measured distances), Tehnički list 1939, No. 1 and 2, 15-18. (NSK; M. Lapaine, GF)
15. Nekoliko misli o novom komasacionom zakonu (A few thoughts about a new commassation law), Geodetski list, Zagreb 1940, 1, 9-20; 1940, 2, 49-54 (NSK; M. Lapaine, GF).
16. O mogućnostima kolonizacije uz komasaciju zemljišta (About possibilities of colonization during the land commassation), Geodetski list, Zagreb 1940, 1, 29-34 (NSK; M. Lapaine, GF).
17. Kritičke napomene katastarskim pravilnicima (Critical remarks on cadastral books of rules), Geodetski list, Zagreb 1940, 2, 67-71 (NSK; M. Lapaine, GF).
18. Dijeljenje trapeza paralelno sa srednjicom (Subdivision of a trapezium by the line which is parallel to its median line), Geodetski list, Zagreb 1940, 3, 97-100 (NSK; M. Lapaine, GF).
19. Opća privredna karta ili katastarski premjer (General economic map or cadastral survey), Geodetski list, Zagreb 1940, 4, 109-112 (NSK; M. Lapaine, GF).
20. Računanje i dijeljenje table raznog boniteta (Computation and subdivision of parcels of heterogeneous values), Geodetski list, Zagreb 1940, 4, 127-129 (NSK; M. Lapaine, GF).
21. Računanje table s jednom nepravilnom međom (Computation of a parcel with a single irregular boundary line), Geodetski list, Zagreb 1940, 4, 129-133 (NSK; M. Lapaine, GF).
22. Komasacija gradilišta (Building-site commassation), Geodetski list 1941, 1, 1-10 (NSK; M. Lapaine, GF).
23. Predgovor trećoj knjizi "Praktične geodezije" (Foreword to the third part of "Practical Geodesy"), Geodetski list, Zagreb 1941, 1, 3-5 (NSK; M. Lapaine, GF).
24. Refrakciona konstanta određena na temelju mjerenja na teritoriju Macedonije (The constant of refraction determined on the basis of measurements performed at the territory of Macedonia), Geodetski list, Zagreb 1941, 2, 34-35 (NSK; M. Lapaine, GF).
25. Pokušaj određivanja refrakcione konstante kod trigonometričkog određivanja visina iz meteoroloških podataka (An attempt to determine the constant of refraction in trigonometric

determination of heights from meteorological data), Geodetski list, Zagreb 1941, 3, 75-77 (NSK; M. Lapaine, GF).
26. Slučaj komasacije P. O. Morović (The case of P. O. Morović commassation), Geodetski list, Zagreb 1941, 3, 82-99 (NSK; M. Lapaine, GF).
27. Da se ne zaboravi (Not to be forgotten), Geodetski list 1941, 4, 100-101 (NSK; M. Lapaine, GF).
28. Još jednom, da se ne zaboravi (Once again, not to be forgotten), Geodetski list 1941, 4, 101-102 (NSK; M. Lapaine, GF).
29. Grafičko izjednačenje koordinata jedne točke (Graphical adjustment of single point coordinates), special reprint from Godišnjak Geodetskog odsjeka, Zagreb, 1942, 81-96 (NSK; M. Lapaine, GF).
30. Određivanje absolutnih deklinacija 53 zenitalnih zviezda (Determination of absolute declination of 53 zenithal stars), special print from Godišnjak Geodetskog odsjeka Tehničkog fakulteta, Zagreb 1942, 1-32. (AGG Faculties Library; NSK)
31. Novi putovi hrvatske geodezije (New ways of Croatian geodesy), Hrvatska državna izmjera, Zagreb 1942, 1-3, 1-13 (M. Lapaine, GF).
32. Određivanje konstanta kod običnog Reichenbachovog daljinomjera (Determination of constants of the simple Reichenbach distance meter), Hrvatska državna izmjera, Zagreb 1942, 1-3, 24-27 (M. Lapaine, GF).
33. Da li se može dopustiti neograničeno podizanje cijena kod komasacije zemljišta? (Is it allowed the price raising without limits in land commassation?), Hrvatska državna izmjera, Zagreb 1942, 1-3, 34-37 (M. Lapaine, GF).
34. † ing. Andrija Wein, Hrvatska državna izmjera, Zagreb 1942, 1-3, 39 (M. Lapaine, GF).
35. Koncentracija geodetske djelatnosti u Hrvatskoj (Concentration of geodetic activities in Croatia), Hrvatska državna izmjera, Zagreb 1942, 4, 41-45 (M. Lapaine, GF).
36. Malo razmatranja o točnosti nivelacije (A little consideration about the levelling accuracy), Hrvatska državna izmjera, Zagreb 1942, 4, 45-47 (M. Lapaine, GF).
37. Rješenje Hansenovog zadatka pomoću računskog stroja (Solution of the Hansen's problem by computer), Hrvatska državna izmjera, Zagreb 1942, 4, 56-58 (M. Lapaine, GF).
38. Gdje treba organizirati hrvatsku državnu izmjeru? (Where one has to organize the Croatian state survey?), Hrvatska državna izmjera, Zagreb 1942, 5, 65-70 (M. Lapaine, GF).
39. Indirektno mjerenje duljina na dva intervala (Indirect distance measuring at two intervals), Hrvatska državna izmjera, Zagreb 1942, 5, 82-86 (M. Lapaine, GF).
40. Određivanje absolutnih deklinacija 53 zenitalnih zviezda (Determination of absolute declination of 53 zenithal stars), Hrvatska državna izmjera, Zagreb 1942, 5, 101 (M. Lapaine, GF).
41. Grafičko izjednačenje koordinata jedne točke (Graphical adjustment of one point coordinates), Hrvatska državna izmjera, Zagreb 1942, 5, 103 (M. Lapaine, GF).
42. Postupovni troškovi kod komasacije zemljišta (Costs of procedure in land commassation), Hrvatska državna izmjera, Zagreb 1942, 5, 98-100 (M. Lapaine, GF).
43. † Krsto Vidnjević, Hrvatska državna izmjera, Zagreb 1942, 5, 104 (M. Lapaine, GF).
44. Da li je sada vrieme za izvedbu komasacija u većem obsegu? (Is it now the right moment to make commassations in larger extent?), Hrvatska državna izmjera, Zagreb 1942, 6-9, 105-108 (M. Lapaine, GF).
45. Određivanje kolebanja geografske širine kod Horrebow-Talcottove metode (Determination of latitude fluctuation in the Horrebow-Talcott method), Hrvatska državna izmjera, Zagreb 1942, 6-9, 120-124 (M. Lapaine, GF).
46. Određivanje Gauss-Krügerovih koordinata pomoću Legendreovog pravila (Determination of the Gauss-Krüger coordinates by using Legendre's rule), Hrvatska državna izmjera, Zagreb 1942, 6-9, 146-152 (M. Lapaine, GF).
47. Hrvatska bibliografija o komasaciji zemljišta (Croatian bibliography on land commassation), Hrvatska državna izmjera, Zagreb 1942, 6-9, 155 (M. Lapaine, GF).
48. Razmatranja o izjednačenju trigonometrički određenih visina (Considerations about the adjustment of trigonometrically determined heights), Hrvatska državna izmjera, Zagreb 1942, 10-11, 177-214 (NSK; M. Lapaine, GF).
49. Pitanje izpita za ovlaštene mjernike (Question of the examination of chartered surveyors), Hrvatska državna izmjera, Zagreb 1942, 10-11, 228-229 (NSK; M. Lapaine, GF).

50. Suradnja ili sukob (Collaboration or conflict), Hrvatska državna izmjera, Zagreb 1942, 10-11, 229-230 (M. Lapaine, GF).
51. Uspomene na moj jedini susret s Ferhadom Kapetanovićem (Memories to my only encounter with Ferhad Kapetanović), Hrvatska državna izmjera, Zagreb 1942, 10-11, 231-232 (M. Lapaine, GF).
52. Nekoliko misli o smjernicama našeg gospodarskog razvitka (A few thoughts on directions of our economic development). In: Izgledi i problemi hrvatskog gospodarstva. Published by Pododbor Matice Hrvatske u Zagrebu, 1943, 9-14.
53. Geodezija (Geodesy). In: Lukas, F. (editor): Naša domovina, Proceedings, Book I, Published by Glavni ustaški stan, Zagreb, 1943, 71-73.

The following four works do not belong to the closer field of geodesy, but they are important and I have put them into the list to make it complete:

54. Spomenica 1942.-1943. (Memorials 1942-1943), Tehnički fakultet Hrvatskog sveučilišta u Zagrebu, Zagreb 1943 (editor).
55. Pisma hrvatskim intelektualcima (Letters to Croatian intellectuals), own edition, Zagreb 1944. (NSK)
56. Memorandum Rektora Hrvatskog sveučilišta (Memorandum of the head of the Croatian University), 1945. (NSK)
57. Mi izbjeglice (We refugees), pp. 240, manuscript written by typewriter, Fermo, 1947. (M: Rosenberg)

Publications published after going away to Argentina

Most of the titles have been translated from Argentinean Spanish into English by M. Lapaine.

1. Compensación de la nivelación de alta precisión (Adjustment of high precision levelling), Anuario del Instituto Geográfico Militar, Volumen XIV, 1952, pp. 16.
2. Calibración provisional del Gravímetro Western G4A No 45 (Provisional calibration of the gravity meter Western G4A No 45), Anuario del Instituto Geográfico Militar, Volumen XIV, 1952, pp. 5.
3. Observaciones gravimétricas en los Puntos Fijos de las Líneas de alta precisión y su compensación (Gravimetric measurements at the points of high precision levelling sections and their adjustment), Anuario del Instituto Geográfico Militar, Volumen XIV, 1952, pp. 25.
4. Determinación exacta de las reducciones en proyección Mercator (Exact determination of the reductions in the Mercator map projection). Revista Cartográfica No 1, pp. 10, Buenos Aires, 1952. (the original author's translation to Croatian kept by M. Lapaine, GF)
5. Resolución de un gran sistema de ecuaciones normales mediante la aplicación de las ideas de Pranis Prañevich y del Profesor Dr. Boltz (Solving the large system of normal equations by using the ideas of Pranis Pranevich and Prof. Dr. Boltz). Publicación No 5 de la Comisión de Cartografía, Comité de Geodesia del Instituto Panamericano de Geographia e Historia, Buenos Aires 1954, No 135, pp. 129 (M. Lapaine, GF)
6. Influencia de la Marea de la corteza terrestre en la nivelación de alta precisión (Influence of high tide and ebb tide of the earth's crust on high precision levelling). Presentation at 10th General Assambly of the IUGG (International Union of Geodesy and Geophysics), Rome, 1954.
7. Consideraciones sobre el sistema gravimétrico mundial (Considerations on the world gravimetric system). Presentation at 10th General Assambly of the IUGG (International Union of Geodesy and Geophysics), Rome, 1954.
8. Nivelación trigonométrica y desviación de la plomada (Trigonometric levelling and the deviation of the vertical). Presentation at 10th General Assambly of the IUGG (International Union of Geodesy and Geophysics), Rome, 1954.
9. Latitud geográfica y movimento del Polo terrestre (Geographic latitude and the earth's pole movement). Presentation at 10th General Assambly of the IUGG (International Union of Geodesy and Geophysics), Rome, 1954.

10. Cálculo de coordenadas geodésicas con máquina (Computation of the geodetic coordinates by computer). Revista Cartográfica No 6, Buenos Aires 1957, 19-48. (M. Lapaine, GF)
11. Reemplazo de la triangulación con una red poligonal de precisión (Substituting of triangulation by precise polygonal network). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata, 1957, Tomo I, No 1, pp. 6.
12. Formación de un gran sistema de ecuaciones normales (Creating the large system of normal equations). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1957, Tomo I, No 2, pp. 6
13. Compensación de poligonales vinculadas a punotos de triangulación (Adjustment of traverses connected to the trigonometric points). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1958, Tomo II, No 1, pp. 16.
14. Consideraciones acerca de la utilización de triangulación en áreas urbanas (Considerations on the need of triangulation in urban areas). Conferencia en el 3er Congreso Nacional de Cartografía. Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La plata 1958, Tomo II, No 2, pp. 6.
15. Algunas observaciones sobre la proyección Gauss-Krüger con las coordenadas reducidas (Some remarks on the Gauss-Krüger map projection with the reduced coordinates). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1958, Tomo II, No 4, pp. 3.
16. Resolución exacta de las ecuaciones normales angulares de los sistemas simples de triángulos (Exact solution of the angle normal equations in the simple triangle systems). Serie tercera No 1, Publicaciones especiales, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1958, pp. 144 (NSK)
17. Fórmulas directas para una proyección doble del elipsoide al plano. Latitud isométrica (Direct formulas for double map projection of an ellipsoid into a plane. Isometric latitude). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1959, Tomo III, No 4, pp. 17.
18. Un método simple para determinar valores numéricos de las funciones $W = \sqrt{1 - e^2 \sin^2 \Phi}$, $V = \sqrt{1 + e'^2 \cos^2 \Phi}$ y sus recíprocos (Simple method for the determination of numerical values of functions $W = \sqrt{1 - e^2 \sin^2 \Phi}$, $V = \sqrt{1 + e'^2 \cos^2 \Phi}$ and their reciprocal values). Revista Cartográfica No 8, Buenos Aires 1959, 35-48 (M. Lapaine, GF)
19. Proyección Gauss-Krüger con coordenadas reducidas (cilindro secante) (Gauss-Krüger map projecion with the reduced coordinates (intersecting cylinder)). Revista Cartográfica No 9, Buenos Aires 1960, 73-97. (M. Lapaine, GF; the original author's translation to Croatian kept by M. Lapaine, GF)
20. Coordenadas Gauss-Krüger y polares Esferóidicas (Gauss-Krüger coordinates and spheroidal polar coordinates). Publicación Técnica No 29, Instituto Geográfico Militar Argentino, Buenos Aires 1960, pp. 40 (M. Lapaine, GF)
21. Problemas y métodos de la Cartografía Geodésica (Problems and methods of geodetic cartography). Conferencia de la Semana de la Cartografía 1960. Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1960, Tomo IV, No 1/4, pp. 10.
22. Fórmulas simples para la transformación de coordenadas en la proyección Gauss-Krüger (Simple formulas for the transformation of coordinates in the Gauss-Krüger map projection). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1961, Tomo V, No 2, pp. 14.
23. Compensación de un punto determinado por intersección de arcos – Trilateración (Adjustment of the point determined by the intersection of arcs – trilateration). Revista Carográfica No 10, Buenos Aires 1961, 51-80. (M. Lapaine, GF)
24. Compensación de un punto nuevo mediante las ecuaciones de condición (Adjustment of a new point by using the condition equations). Publicación Técnica No 32, Instituto Geográfico Militar Argentino, Buenos Aires 1962, pp. 50 (M. Lapaine, GF)

25. Transformación de coordenadas en la proyección Gauss-Krüger. Formulas para computadoras electrónicas (Transformation of coordinates in the Gauss-Krüger map projection. Formulas for computers). Revista Cartográfica No 12, Buenos Aires 1963, 87-118. (M. Lapaine, GF)
26. Un método simple para determinar los valores numéricos de las constantes en la esfera de Gauss (Simple method for the numerical values determination of the Gauss sphere constants). Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1963, Tomo VII, No 1/2, pp. 8.
27. Funciones de ángulos pequeños (Functions of small angles). Revista Geodesia, Direcction de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1963, Tomo VIII, No 1, pp. 8.
28. Compensación de uno o varios puntos nuevos por coordenadas. Procedimiento adaptado al cálculo con computadoras electrónicas (Adjustment of one or more new points by coordinates. A method adapted for the computation with computers). Revista Cartográfica No 13, Buenos Aires 1964, 41-80. (M. Lapaine, GF)
29. Compensación de la interesección analitica combinada de arcos y rectas (Analitical adjustment of the combined intersection of arcs and directions). Revista Cartográfica No 14, Buenos Aires 1965, 45-56. (M. Lapaine, GF)
30. Un método simple para resolver las ecuaciones normales compuesta en parte de las ecuaciones angulares (Simple method for solving normal equations formed partially from angle conditions). Serie tercera No 16, Publicaciones especiales, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1965, 1-119. (NSK; M. Lapaine, GF; the original author's translation to Croatian with large appendix kept by M. Lapaine, GF)
31. Modificaciones del procedimiento de desarrollo de Boltz para la aplicación de matrices inversas (Modification of the method of derivation by Boltz with the application to the inverse matrices). Revista Cartográfica No 15, Buenos Aires 1966, pp. 24.
32. Compensación de una triangulación mediante la transformación de coeficientes de las ecuaciones de error (Adjustment of triangulation network by transforming the coefficients of the observation equations). Publicación Técnica No 39, Instituto Geográfico Militar Argentino, Buenos Aires 1966, pp. 47 with 29 tables (M. Lapaine, GF)
33. Fórmulas simplificadas para calcular las funciones (Simplified formulas for the computation of functions) $W = \sqrt{1 - e^2 \sin^2 \Phi}$, $V = \sqrt{1 + e'^2 \cos^2 \Phi}$. Revista Geodesia, Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1966, No X, 1, pp. 8.
34. Cálculos en la proyección estereográfica (Computation in stereographic projection), published as manuscipt, la Dirección de Geodesia. La Plata 1966 (see Fórmulas para calcular ..., La Plata 1967).
35. Fórmulas para calcular la latitud isométrica y sus funciones (Formulas for the computation of the isometric latitude and its functions). Geodesia, Revista de la Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1967, XI-2, 9-32 (M. Lapaine, GF)
36. Conversión de las coordenadas Gauss-Krüger (Transformation of the Gauss-Krüger coordinates). Revista Cartográfica No 16, Buenos Aires 1967, 29-53 (M. Lapaine, GF)
37. Problemas de cálculo geodésico representados en las formas correspondientes a la aplicación de las computadoras electrónicas. Cálculos relacionados con el elipsoide. (Problems of geodetic computations, represented in forms appropriate for the computer applications. Computations in relation to an ellipsoid) Publicación Técnica No 41, Instituto Geográfico Militar Argentino, Buenos Aires 1968, pp. 168 (M. Lapaine, GF)
38. Coordenadas planas rectangulares Gauss-Krüger, Nuevas formulas y tablas para calculo con maquina (Gauss-Krüger plane rectangular coordinates, New formulas and tables for computer computation) Publicacion Tecnica No. 9, Instituto Geografico Militar, Buenos Aires 1967, pp. 20 + 70 pages of tables (N. Frančula, GF)
39. Resolución de problemas de cálculos geodésico-topográficos con la calculadora electrónica IME-NCR (Solving problems in geodetic and topographic computation by means of electronic computer IME-NCR). Instituto Geográfico Militar Argentino, Bunos Aires 1968, pp. 90 (M. Lapaine, GF)

40. Conversión de coordenadas Gauss-Krüger (Transformation of the Gauss-Krüger coordinates). Publicación Técnica No 42, Instituto Geográfico Militar Argentino, Buenos Aires 1968, pp. 25 (M. Lapaine, GF; NSK)
41. Nuevas fórmulas para calcular las magnitudes relacionadas con el elipsoide terrestre. Su adaptacion al cálculo mecanizado (New formulas for the computation of numerical values related to the earth ellipsoid. Their application to the mechanized computation). Presented at Primer Simposio Continental sobre Geografía y Cartografía en Quito – Ecuador – 1968. Publicación Técnica No 43, Instituto Geográfico Militar Argentino, Buenos Aires 1969, 1-66. (M. Lapaine, GF)
42. Fórmulas y tablas para la conversión de las coordenadas Gauss-Krüger (Formulas and tables for the transformation of the Gauss-Krüger coordinates). Publicación Técnica No 44, Instituto Geográfico Militar Argentino, Buenos Aires, 1969, pp. 35 (M. Lapaine, GF)
43. Cálculos en la Proyección Estereográfica. Contribución al estudio sobre la proyección más conveniente para las áreas urbanas (Computation in stereographic map projection. Contribution to the study on the best map projection for the rural areas). Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata, 1969.
44. Cálculo de distancia y acimut entre dos puntos dados por sus coordenadas geográficas (Computation of the distance and the azimuth between the two points given by their geographical coordinates). Geodesia, Revista de la Direccion de Geodesia, Ministerio de Obras Publicas, Provincia de Buenos Aires, La Plata 1969, XIII 1-2, 9-26 (M. Lapaine, GF)
45. Determinación de la Latitud Geográfica conociendo el Arco Meridiano – Fórmulas, Tablas y procesos de Cálculos (Determination of geographic latitude knowing the length of the meridian arc – formulas, tables and the method of computation). Revista Cartográfica No 21, Buenos Aires 1971, 107-116. (M. Lapaine, GF)
46. Cálculo numérico con ángulos relativamente pequeños (Numerical computation with the relative small angles). Publicación No 331 de la Comisión de Cartiografía del Instituto Panamericano de Geographia e Historia, Buenos Aires 1971, pp. 113 (N. Frančula, GF; M. Lapaine, GF)
47. Determinacion de puntos trigonometricos de segundo orden (Determination of the second order trigonometric point). E. Horvat and R. Rodriguez, Comunicaciones cientificas y de actividades, VI Reunion cientifica de la Asociacion Argentina de geofisicos y geodestas, Instituto Geografico Militar, Departamento Geodésico, Mendoza 1971, 3-9. (M. Lapaine, GF)
48. Investigacion sobre la precision de la triangulacion fundamental (Testing the precision of the fundamental triangulation). Comunicaciones cientificas y de actividades, VI Reunion cientifica de la Asociacion Argentina de geofisicos y geodestas, Instituto Geografico Militar, Departamento Geodésico, Mendoza 1971, 11-28 with two separate sketches (M. Lapaine, GF)
49. Reducciónes de la Proyección Mercator Expresadas por las Coordenadas Rectangulares (Reductions in the Mercator map projection expressed by cartesian coordinates). Revista Cartográfica No 22, Buenos Aires 1972, 203-213. (M. Lapaine, GF)
50. Determinacion de puntos trigonometricos de segundo orden (Determination of the trigonometric points of the 2nd order) Geoacta, 1973, Vol. 6, No. 2, 17-22, authors E. Horvat and R. Rodriguez (M. Lapaine, GF)
51. Investigacion sobre la precision de la triangulacion fundamental (Research on the precision of fundamental triangulation) Geoacta, 1973, Vol. 6, No. 2, 23-36 (M. Lapaine, GF)
52. Cálculo y Compensación de Sistemas Poligonales. Primera Parte: Problemas Generales relacionados con los Sistemas Poligonales. Segunda Parte: Sistemas Poligonales Intercalados. Tercera Parte: Sistemas Poligonales Libres o Vinculados indirectamente a puntos Trigonométricos (Computation of adjustment of the traverse networks. 1st part: General problem related to the travers networks. 2nd part: System of inserted traverses. 3rd part: Travers network which is free or indirect connected to the trigonometric point). Publicación No 348, Instituto Panamericano de Geographia e Historia, Buenos Aires, 1973, pp. 430 (see the next publication)
53. Cálculo y Compensación de sistemas poligonales (Computation of adjustment of the traverse networks). Publicación Técnica No 45, Instituto Geográfico Militar Argentino, Buenos Aires, 1973, in three volumes (Primera parte: Problemas generales relacionados con los sistemas poligonales, 1-116; Segunda parte: Sistemas poligonales intercalados, 1-198; Tercera parte: Sistemas poligonales libres o vinculados indirectamente a puntos trigonometricos, 1-116;

altogether 430 pages) (M. Lapaine, GF; partial author's translation to Croatian kept by M. Lapaine GF)

54. Desarrollo matemático, orden de operaciones y medios modernos de calculo numérico (Mathematical derivations, the order of operations and the modern computational devices). Presented at Simposio Internacional sobre Métodos de Computación en Geodesia Geométrica de la Asociación Internacional de Geodesia, Universidad de Oxford, 1973, Comité Nacional de la UGGI, 1-34. (N. Frančula, GF; M. Lapaine, GF)
55. Algunos Conceptos Críticos sobre los Errores de Observación y su Compensación (Some critical concepts on the errors in observations and the adjustment). Revista Cartográfica No 29, Mexico 1976, 201-210. (M. Lapaine, GF)
56. Latitud Geocéntrica y sus relaciones con las Latitudes Reducida y Geográfica (Geocentric latitude and its relationships to the reduced and geographical latitude). Revista Cartográfica No 33, Mexico 1978, 25-39. (M. Lapaine, GF)
57. Funciones hiperbolicas, sus fórmulas más frecuentes y su aplicación en los problemas geodésicos (Hyperbolic functions, their most frequent formulas and the application to geodetic problems). Publicación Técnica No 47, Instituto Geográfico Militar Argentino, Buenos Aires 1980, pp. 30 (M. Lapaine, GF). There is a translation to Croatian of the author himslef (manuscript kept by N. Frančula, GF)
58. Izjednačenje triangulacije (Adjustment of the triangulation network), manuscript in Croatian, Buenos Aires, about 1970, pp. 358 (kept by K. Šimičić, GF)
59. Skema Doolittle za rješenje normalnih jednadžbi (Scheme of Doolittle for solving normal equations, in Croatian), pp. 3 +2 tables (manuscript kept by M. Lapaine, GF)

4. Scientific work

Stjepan Horvat dealt in Zagreb with mathematical processing of geodetic measurements (1, 2, 9, 18, 20, 21, 30, 37, 41, 48), geodetic cartography (3, 4, 5, 8, 11, 12, 13, 46), higher geodesy and geodetic astronomy (5, 29, 38, 40, 45), engineering and practical geodesy (6, 7, 10, 14, 15, 16, 17, 19, 21, 23, 24, 25, 26, 27, 28, 31, 32, 33, 35, 36, 39, 42, 44, 47, 49). The numbers in brackets refer to the ordinal number given in the previous chapter in the list of works published until 1945.

His activity in Argentina referred to mathematical processing of geodetic measurements (1, 5, 10, 12, 13, 16, 23, 24, 27, 28, 29, 30, 31, 32, 36, 37, 39, 44, 48, 49, 50, 51, 53, 55), gravimetry (2, 3, 7), physical geodesy (6, 8, 9), higher geodesy (11, 14, 45, 46, 54) and geodetic cartography (4, 15, 17, 18, 19, 20, 21, 22, 25, 26, 33, 34, 35, 38, 40, 41, 42, 43, 47, 52). The number in brackets refer to the ordinal number of the work given in the previous chapter in the list of works published after his arrival to Argentina.

The overview given above indicates that in his entire working period Horvat was mostly interested in mathematical processing of geodetic data. He was dealing mostly with the problems of adjustment calculus, and from 1960 also with the application of computers in the processing of geodetic measurements. The majority of other works could also be enlisted into the works belonging to the field of mathematical processing the geodetic data since Horvat was not satisfied only with theoretical consideration but always used to examine the practical application of the procedures he was working on.

Since the extent of the works by Horvat that have been published is exceptionally large, we shall focus further in the paper on his contribution to geodetic cartography, the other large area of his interest. This is a part of cartography that is mostly concerend with the projection of rotational ellipsoid into the plane, for the purpose of state survey and official cartography.

Since three conformal systems of Gauss-Krüger projection were chosen for the area of Yugoslavia at that time, there is a large number of points in the vicinity of the adjoining belt among two systems that had to be presented with rectangular co-ordinates in both systems. In the paper *Calculation of Co-ordinates in Gauss-Krüger Projection* (1930) Horvat considers the determination of meridian convergence (local orientation), determination of local length distortion, dependence of meridian convergence on the change of point position. He suggests different way of determining local length reduction by means of rectangular co-ordinates.

The textbook *Praktična geodezija, II. deo, Državna izmera I* (1931) consists of three more chapter apart from the introduction:

I Geodetic computations problems on sphere

II Geodetic computation problems on spheroid

III Geodetic cartography (globe projection into the plane)

(1. General part, 2. General case of conical projections, 3. Mercator projection, 3. Stereographic projection, 5. Transformation of plane conformal co-ordinates).

In the next book *Praktična geodezija, II. deo, Državna izmera II* (1932) there are also three chapters:

I. Geodetic computation problems on spheroid

(1. Normal cross-sections, 2. Geodesics and its basic properties, 3. Solutions of some computation problems on ellipsoid surface, 4. Spheroidal Soldner co-ordinates)

II. Continuation of geodetic cartography

(1. Gauß conformal projection of an ellipsoid onto a sphere, 2. Gauß direct projection of an ellipsoid on an elliptical cylinder, 3. Double and direct projections of ellipsoid into the plane, 4. Transformation of co-ordinates)

III. Triangulation on ellipsoid surface and its computation

Appendix - Short overview of triangulation in Yugoslavia.

In his paper *Transverse aspect of conformal cylindrical co-ordinates* (1937) Horvat deals with map projection that belongs to the group of double projections, i.e. first a part of ellipsoid surface is projected onto the Gauß sphere, and from the sphere by means of Mercator cylindrical projection into the plane. The paper also deals with the projections of ellipsoid surface onto the Gauß sphere, determination of auxiliary co-ordinates from geographic co-ordinates, determination of meridian convergence from plane co-ordinates, and direct and indirect transformation of plane conformal co-ordinates.

In 1939 Horvat published two works in the prestige periodical *Zeitschrift für Vermessungswesen*. In the paper *Transformation stereographischer Koordinaten* Horvat considers the problem of transformation among various systems of stereographic projection, understood as double projections, where various systems have the same Gauβ globe (the example of old systems in Hungarian survey). In the paper *Neue Formeln zur Bestimmung der rechtwinkligen Koordinaten bei konformer Abbildung der Kugel oder des Ellipsoids auf einen Kegel* (New Formulas for Determination of Rectangular Co-ordinates in Conformal Projections of Globe or Ellipsoid onto the Cone) Horvat suggests a new formula form for conformal conical projections with one standard parallel that are more convenient for numeric computation. This paper is quoted in one of the most famous geodetic manuals (Jordan/Eggert: Handbuch der Vermessungskunde, Dritter Band, Zweiter Halbband, Achte erweiterte Auflage, Stuttgart, J. B. Metzlersche Verlagsbuchhandlungs 1941, page 233).

In the paper *Determination of Gauβ-Krüger Co-ordinates by means of Legendre's Rule* (1942) Horvat deals with direct and inverse problem of determining Gauß-Krüger co-ordinates.

The first works that Horvat published in Argentina appear in 1952. In the paper *Determinación exacta de las reducciones en proyección Mercator* (Exact Determination of Reductions in Mercator Projection) Horvat considers normal aspect of Mercator projection where equator was taken as a standard parallel. The obtained solution can be applied for every aspect of that projection, if the right equator is replaced by the auxiliary one and geographic co-ordinates with spherical rectangular co-ordinates referring to the auxiliary equator.

For some of Horvat's works published in Argentina only the translation of titles from Argentinean Spanish into Croatian and English is familiar to us so far. But the titles themselves lead to the conclusion that these works deal with the problems of map projection theories:

Algunas observaciones sobre la proyección Gauss-Krüger con las coordenadas reducidas (Some observations referring to Gauss-Krüger projection with reduced co-ordinates), 1958.

Fórmulas directas para una proyección doble del elipsoide al plano. Latitud isométrica (Direct formulas for a double projection of ellipsoid into the plane. Isometric latitude), 1959.

Coordenadas Gauss-Krüger y polares Esferóidicas (Gauss-Krüger and spheroid polar co-ordinates), 1960.

Fórmulas simples para la transformación de coordenadas en la proyección Gauss-Krüger (Simple formulas for transformation of co-ordinates into Gauss-Krüger projections), 1961.

Transformación de coordenadas en la proyección Gauss-Krüger. Formulas para computadoras electrónicas (Transformation of co-ordinates in Gauss-Krüger projections. Formulas for electronic computers), 1963.

Conversión de las coordenadas Gauss-Krüger (Transformation of Gauss-Krüger co-ordinates), 1967.

Coordenadas planas rectangulares Gauss-Krüger, Nuevas formulas y tablas para calculo con maquina (Gauss-Krüger plane rectangular co-ordinates, New formulas and tables for computation by using computer), 1967.

Conversión de coordenadas Gauss-Krüger (Transformation of Gauss-Krüger co-ordinates), 1968.

Fórmulas y tablas para la conversión de las coordenadas Gauss-Krüger (Formulas and tables for the transformation of Gauss-Krüger co-ordinates), 1969.

Cálculos en la Proyección Estereográfica. Contribución al estudio sobre la proyección más conveniente para las áreas urbanas (Computation in stereographic projection. Contribution to the study on the most convenient projections for city areas), 1969.

Determinación de la Latitud Geográfica conociendo el Arco Meridiano – Fórmulas, Tablas y procesos de Cálculos (Determination of latitude with known meridian arc – formulas, tables and computing procedure), 1971.

Reducciónes de la Proyección Mercator Expresadas por las Coordenadas Rectangulares (Reductions in Mercator projection expressed by rectangular co-ordinates), 1972.

In the paper *Proyección Gauss-Krüger con coordenadas reducidas* (*cilindro secante*) from 1960, Horvat is dealing with Gauss-Krüger projection and the consequences of its application by introducing various linear deformations along the central meridian. In his final considerations Horvat says that a single projection is not used only for graphic presentation of a certain area, but also for general purposes in geodesy and in other applications. Exactly those remarks are a decisive argument speaking for the conformal projections to be chosen for the purpose of geodetic projections. Conformal projections makes the solution of various geodetic computation problems easier. Apart from the base triangulation of some country, all other computations are made in the projections plane, i.e. by means of plane geometry rules. In order to do it, it is necessary to reduce measured angles into the plane by means of the appropriate reductions. Thus reduced measurements can be considered as being realised directly in the projection plane.

The above mentioned reductions belong to simple computations if triangulation data are involved. For this purpose one should be familiar with the co-ordinates of points in the plane, but with the accuracy of 10 to 20 m, which can be achieved by simple and quick calculation, that should be done also for some other purposes (spherical excesses, centering and other auxiliary calculations). In many other cases the numeric calculation can be replaced by graphic constructions with provided necessary accuracy.

The problem of measurement reduction into the plane is different in traversing. It implies measuring angles and distances. The angles usually need no reduction, but the sides should always be reduced into the plane if large linear distortions appear, or their rapid changes are involved. Although it is not especially complicated, this reduction demands a lot of work to be done, because it relates to the operation appearing in great quantities, and hence, such reduction calculation takes a lot of time. Therefore, the projection with large deformations or their rapid changes causes larger difficulties of practical nature.

If it relates to cartographic problems only, then linear distortion has almost no significance according to Horvat, above all in conformal map projections. Linear and also areal distortions mean in

term of cartography some small change of map scale. Apart from that, the designing of plans and maps is faced with other deformations, perhaps even significantly larger that are caused by the instability of the used paper and by the printing procedure.

At the end of the paper *Proyección Gauss-Krüger con coordenadas reducidas* (*cilindro secante*), Horvat presents good and bad sides of introducing linear deformation along the central meridian of the projection area, looking back thereby especially to the position and size of Argentina.

This paper by Horvat from 1960 is presented in more details because of its up-to-dateness in Croatia, as well as in other countries that should solve the problem of their geodetic datum and official map projections in the near future.

5. Instead of conclusion

According to F. Braum (1992), Horvat is given credit for geodetic teaching activities in high education institutions at the time, as personal, instrumental and material circumstances in general were very poor. He is also responsible for writing the scripts that were rarely made, and for raising geodetic activity to the necessary scientific level. Due to Professor Horvat, the present Faculty of Geodesy, and the geodetic high education studies within the frame of the Technical Faculty in Zagreb has overcome its crisis in Yugoslavia of that time. Horvat was preceded by a Hungarian, A. Fasching, very good expert who lectured in German since he could not speak Croatian and therefore could not stay in Zagreb. He was replaced by Pavle Horvat, civil engineer who got severely ill in 1933. At that time, the top geodetic professionals were surveyors and "geodesists" who completed Geodetic Course, and civil or forestry engineers. Horvat took it on his chin then and maintained geodetic studies with the help of, first of all, Prof. N. Abakumov, and later of S. Macarol and R. Golubović. Horvat was the main bearer of those studies even at the time of NDH. These studies gave experts that could continue the development of high educational geodetic studies after his departure to Argentina and advance it. Horvat was interested in that development even while being an emigrant, its successfulness made him happy and he sent to Zagreb his publications.

According to M. Blažeković, Horvat was the "most appreciated authority among Croatian emigrant in Buenos Aires. It can be proved by the example of intellectual gathering that took place in 1975 in Croatian-Argentinean Cultural Club in Buenos Aires on the occasion of the Horvat's 80th birth anniversary. As he was brought the entire gathering stood up. It was a true manifestation of appreciation to Horvat. The fact that he used to be brought ill into the Military Geographic Institute may illustrate how valuable he was to the Argentinean military circles as the top expert."

The following statements are the evidences of the reputation that Horvat used to enjoy in Argentinean military circles:

Referring to the paper *Cálculo numérico con ángulos relativamente pequeños* (Numeric computation with relatively small angles), 1971: “This unpublished paper presented by the engineer Esteban Horvat (IGMA) at the gathering *XI Reunión Panamericana de Consulta sobre Cartografia*, was pointed out with the reference to be published because of its scientific value...". Signed by: Oscar Juan Hector Colombo, General de Brigada, Presidente Comisión de Cartografiy, Instituto Panamericano de Geografía e Historia.

In the foreword of the paper *Funciones hiperbolicas, sus fórmulas más frecuentes y su aplicación en los problemas geodésicos* (In the foreword of the paper Hyperbolic functions, their most frequent formulas and application in geodetic problems), 1980 there is the following to be read: “Engineer E. Horvat, Personal Superior of IGMA is a devoted and experienced user of hyperbolic functions and one of the first that have introduced them into the mathematical cartography. In this monograph the basic formulas about their relations and application in concrete problems – transverse Mercator projection, conformal conical and Gauss-Krüger projection, are presented in details”. Signed by: Luis Jorge Borrelli, Coronel, Director IGMA. The copy of the first page of the author’s manuscript of this work in Croatian language is presented on Fig. 1.

In 1944 in Croatia he received an Order of Merit with a Star, and in Argentina he received a medal by the Argentinean Army in 1969 (Ejercito Argentino, see Fig. 2), in 1973 a medal as the sign of gratitude by the Military and Geographic Institute (El Instituto Geografico Militar, see Fig. 3), and in 1979 he received a medal as an honorary member of the Argentinean Society of Geophysicists and Geodesists (Asociacion Argentina de Geofisicos y Geodestas, see Fig. 4).

At the end of this presentation it should be best to give the chance to Stjepan Horvat to introduce himself through the letter delivered from Argentina in 1967 to Zagreb to Mr. Drago Mihajlović. The letter was kept Marijan Rosenberg, the son of Mr. Drago Mihajlović, and I appreciate it with thanks to him to have allowed this letter to be published.

Dear Godfather!

It has been long since our last contact, so I do no recall exactly what has come and gone in the meantime. It is not that I have forgotten You, we often speak about You and Yours, Ljubica and me. I must admit that I have become unable to take care of correspondence. I do not remember my last letter written to somebody. To busy? Yes, too much occupied with daily duties, with studying problems that crop up every day and demand larger and larger effort spending more and more time. It should be understood that in my age I cannot count with long period of working ability and that I try to leave something written from very fruitful professional experience. I would like to do the impossible, I would like to put a final point to my life activity. But it is almost certain that everything will finish with colon with no continuation after that.

As you most probably know, I had a traffic accident 4 years ago. At first, everything seemed so simple, small bone fracture on my left leg. But later on it became more complicated, probably because of poor treatment, so I got arthritis in my left knee. After being such for a long time and having severe

pains, I ended up with a stiff knee. Fortunately, the consequences were not so difficult otherwise. Both institutions in which I work as technical adviser send a car to my house that takes me to work. I would have to apply for a pension otherwise that is miserably small here. Fortunately, it all ended well, and I can go on working without any problems, and since I am not able to move so much now the work has become more intensive and yields more results. Since that time there have been two special publications issued, apart from several papers in professional periodicals. One of the publications has been sent to You by the publisher, and I will send the other shortly together with some earlier publications that I have saved in a few copies for that purpose.

One of the publications is just being worked on and will be published in the form of a manuscript (in order to have reduced expenses). The other larger staff (about 150 pages) is just being prepared and will be in the procedure this year.

I have kept the extract translated into Croatian for the book I have sent to you, and I will send it to Your together with other things.

The manuscript contains a text with numerous examples of the study about computing and adjustment of polygonal systems. The book has got about 300 pages and, if I am lucky, it might be published next year. I have made a translation from this book from the chapters 1, 3 and 5, i.e. the most important parts that could be of interest to You. I am sending it attached to this letter, there might be some remarks about the Croatian text, first of all in terms of language. It is not surprising, because I have been thinking and writing professional staff in Spanish for years, and now I have difficulties in expressing myself well in Croatian. This is a destiny, you know, I write Spanish very well, but far from being perfect, and I have lost the ease and lucidity I used to have in my Croatian.

University Library has got only two of my publications at the moment. I am ready to send all of them to it that have been published so far, so it would be kept at one place if anyone ever would be interested in getting acquainted with my work here. There are a lot of valuable things in the published material. There are also some computation problems that have been accepted here and have found their application. There are several things that were used as the basis for automated computation with electronic computers. There is also a publication being prepared that relates to these issues.

I have no illusions and am aware of the fact that my name is odious for many people in Croatia. But in spite of them, I still live and work. And I have credible evidence of my work. I am already old – I will be 71 soon – but I am still very fresh psychically and can create better than many younger people. And I have not been impoverished by their taking away my manuscripts. They are of small value now, because the times has passed and everything has taken a new direction. New times require new solutions, and I also give small contribution to it. I am not making a mistake and overestimating my work here, I know that many things are history already. But I also do not intend to make a mistake of underestimating my work, something that has been done has got its current value. Many things are still applied here, and I hope that it will have its future for some time.

I would like – if God's Providence would allow it and I stay healthy and able to work – to gather my experience in two scripts. One of them, the smaller one, refers to computation problems in geodetic cartography. The other, a significantly larger one, refers to the problems of adjustment. A part of it has already been written, the one referring to polygonal systems. There is an important part to be made that deals with adjustment in general and especially with triangulation, fundamental and specialised. If I decide to do it, or better to say, if I will be able to write this, I will try to write both in Croatian and Spanish. In that case I will send the Croatian manuscript to the University Library to keep it as a historical document that should prove how much a Croat meant in this field.

I am sending to You a list of publications that will be sent to the University Library. If there is someone in there, who is interested in it, it would be good to know where he/she can be found.

This year there was a symposium held in Belgium on geodetic computation. There were two our delegates participating and presenting reports on transformation of geographic into Gauss-Krüger co-ordinates and inverse, adapted for electronic calculation. I am the author, and it is pointed out in the report. It is interesting that on this occasion – as I can see from the list of participants – there was also the engineer M. J. present, but he did not try to contact our delegates. But a participant from Slovenia did it. I do not remember him, but he claimed to be my student. He inquired about me, sent his regards and his visiting card. It only confirms this Latin proverb "Nemo propheta in patria". Unless – some other reasons are involved!

Many Greeting to You and Yours
Sincerely Yours

Stjepan

Ljubica sends her regards, too.

Acknowledgement

I express my gratitude to the S. Horvat daughters, Mrs. Ljubica Horvat and Mrs. Vjera Ostović, as well as to granddaughter Lovorka for borrowing me the documents and photographs. My gratitude is not less due to Mr. Marijan Rosenberg for giving me the publications and manuscripts by S. Horvat. I also appreciate with thanks the help offered to me by Dr. Mirela Slukan-Altić in searching necessary documents that are kept in the Croatian State Archives.

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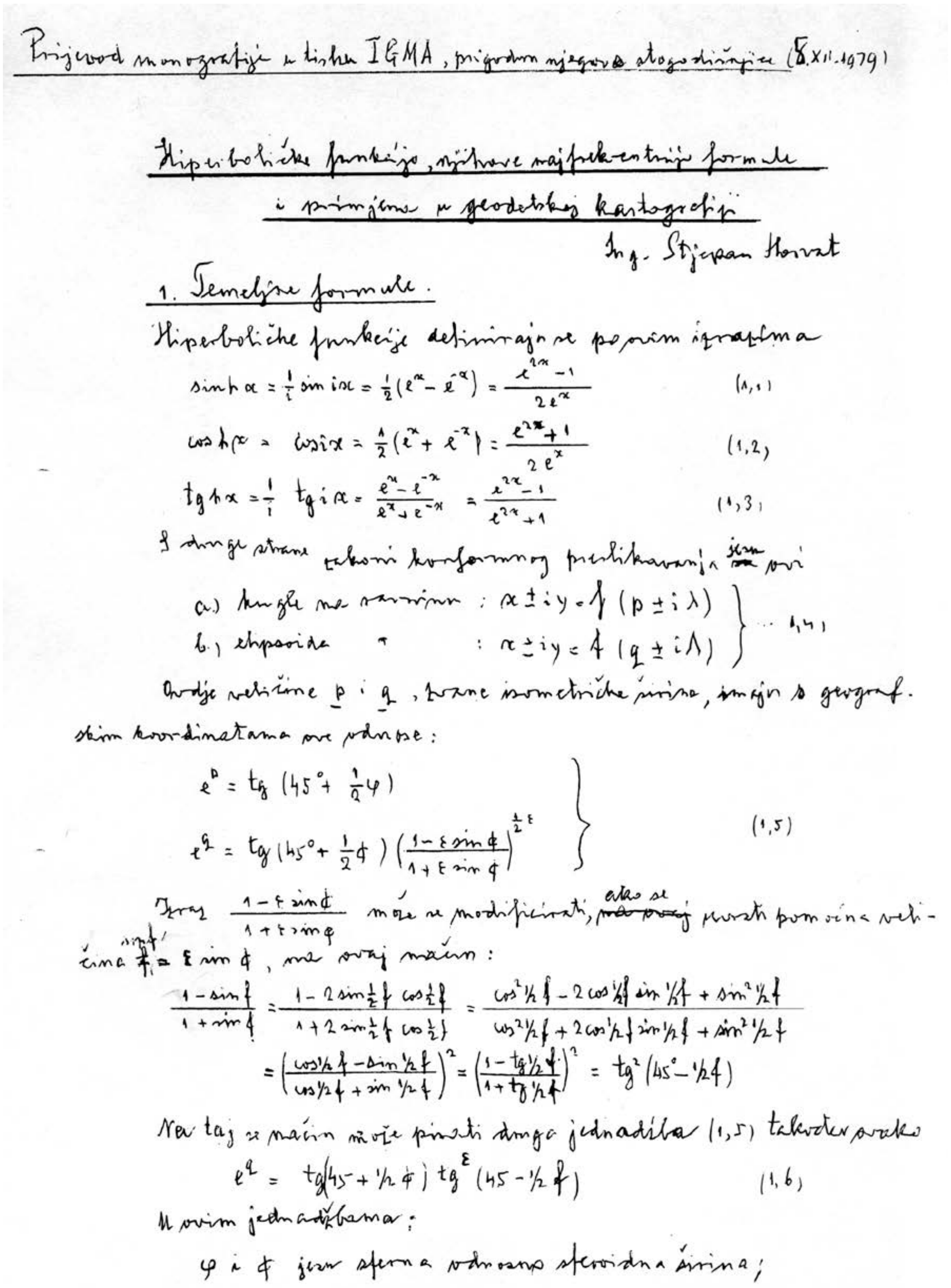
Stjepan Horvat



Prijevod monografije u tisku IGMA, prigodom njegove stogodišnjice (8.XII.1979)

Hiperbolične funkcije, njihove najfrekventnije formule i primjena u geodetskoj kartografiji

Ing. Stjepan Horvat

1. Temeljne formule.

Hiperbolične funkcije definiraju se pomoću izraza

$$\sinh x = \frac{1}{i}\sin ix = \frac{1}{2}(e^{x} - e^{-x}) = \frac{e^{2x}-1}{2e^{x}} \qquad (1,1)$$

$$\cosh x = \cos ix = \frac{1}{2}(e^{x} + e^{-x}) = \frac{e^{2x}+1}{2e^{x}} \qquad (1,2)$$

$$\mathrm{tgh}\, x = \frac{1}{i}\mathrm{tg}\, ix = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}} = \frac{e^{2x}-1}{e^{2x}+1} \qquad (1,3)$$

S druge strane zakoni konformnog preslikavanja jesu ovi

a.) kugle na ravninu : $x \pm iy = f(p \pm i\lambda)$

b.) elipsoida " : $x \pm iy = f(q \pm i\Lambda)$ (1,4)

Ovdje veličine p i q, zvane izometrične širine, imaju s geograf. skim koordinatama ove odnose:

$$e^{p} = \mathrm{tg}(45° + \tfrac{1}{2}\varphi)$$

$$e^{q} = \mathrm{tg}(45° + \tfrac{1}{2}\Phi)\left(\frac{1-\varepsilon\sin\Phi}{1+\varepsilon\sin\Phi}\right)^{\frac{1}{2}\varepsilon} \qquad (1,5)$$

Izraz $\frac{1-\varepsilon\sin\Phi}{1+\varepsilon\sin\varphi}$ može se modificirati, ako se uvede pomoćna veličina $\sin f = \varepsilon\sin\Phi$, na ovaj način:

$$\frac{1-\sin f}{1+\sin f} = \frac{1-2\sin\frac{1}{2}f\cos\frac{1}{2}f}{1+2\sin\frac{1}{2}f\cos\frac{1}{2}f} = \frac{\cos^2\frac{1}{2}f - 2\cos\frac{1}{2}f\sin\frac{1}{2}f + \sin^2\frac{1}{2}f}{\cos^2\frac{1}{2}f + 2\cos\frac{1}{2}f\sin\frac{1}{2}f + \sin^2\frac{1}{2}f}$$

$$= \left(\frac{\cos\frac{1}{2}f - \sin\frac{1}{2}f}{\cos\frac{1}{2}f + \sin\frac{1}{2}f}\right)^2 = \left(\frac{1-\mathrm{tg}\frac{1}{2}f}{1+\mathrm{tg}\frac{1}{2}f}\right)^2 = \mathrm{tg}^2(45° - \tfrac{1}{2}f)$$

Na taj se način može pisati druga jednadžba (1,5) također ovako

$$e^{q} = \mathrm{tg}(45 + \tfrac{1}{2}\Phi)\,\mathrm{tg}^{\varepsilon}(45 - \tfrac{1}{2}f) \qquad (1,6)$$

U ovim jednadžbama:

φ i Φ jesu sferna odnosno sferoidna širina;

Fig. 1. Copy of the first page of the manuscript being Horvat's own translation of the work *Funciones hiperbolicas, sus fórmulas más frecuentes y su aplicación en los problemas geodésicos* into Croatian

Fig. 2. Medal that S. Horvat received from the Argentinean Army in 1969

Fig. 3. Medal given to S. Horvat in expressing gratitude
by the Argentinean Military and Geographic Institute in 1973

Fig. 4. Honorary member medal by the Argentinean Society of Geophysicists
and Geodesists given to S. Horvat in 1979