THE REPUBLIC OF HUNGARY

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The first topographic survey of Hungary was conducted from 1763 to 1787 and was termed the “Josephsinsche Aufnahme.” The Liesganig triangulation and attached supplemental surveys were executed graphically with plane table and alidade. There was no geodetic survey used as a foundation. The associated topographic survey was performed at a scale of 1:28,800 and was based on the Vienna Klafter System where 1 Zoll = 400 Klafter = 758.6 meters. Altogether there were about 4,500 sheets surveyed and all of them were kept secret for military purposes.

The second topographic survey of Northern Hungary (Französische Aufnahme) was conducted from 1810 to 1866. The Vienna Datum of 1806 was established based on the origin of St. Stephen’s Tower (Stephan Turm) and the 1:25,000 mapping scale was introduced along with the polyeder (polyhedral) projection to eliminate inconsistencies in map sheet lines. Remember that in past columns I have pointed out that the polyhedral projection is mathematically equivalent to the local space rectangular (LSR) coordinate system that is commonly used in computational photogrammetry.

In 1874, the Budapest Stereographic Projection was defined at Gellértvár (Gellért Hill) for an-dated cylinders touch the Gaussian sphere along the great circles perpendicular to the meridian at the following origins: 47° 29′ 09″ North and 46° 26′ 23″ East of Ferro and α = 100° 47′ 07″ to the Laplace station Széchenyihegy. In 1908, a system of three cylindrical projections was introduced, all with the Central Meridian of Budapest. The oblique cylinders touch the Gaussian sphere along the great circles perpendicular to the meridian at the following origins: 48° 42′ 56″ North and 6.44 arc seconds with the Budapest Stereographic Grid of 1874.

The third topographic survey of Hungary (Neue Aufnahme) was conducted from 1869 to 1896 and was based on the Arad, St. Anna Datum of 1840, where the origin was: \( \Phi = 46° 18′ 47.63″ \) North, \( \lambda = 39° 06′ 54.19″ \) East of Ferro (geodetically determined from Vienna). This Datum was referenced to the Zach ellipsoid and was used for the Third Topographic Survey of Hungary. The defining azimuth to Kurtics was determined astronomically, but the angular value was not published and is now lost. The metric system was legally established in 1872, and the 1:25,000 mapping scale was introduced along with the polyhedral projection to eliminate inconsistencies in map sheet lines. Remember that in past columns I have pointed out that the polyhedral projection is mathematically equivalent to the local space rectangular (LSR) coordinate system that is commonly used in computational photogrammetry.

In 1878, Central Hungary was measured from 1881-1884. North-ern Hungary was surveyed from 1875-1878 and Western Hungary was surveyed from 1878-1880, the latter two by the use of cadastral planimetry.

The fourth topographic survey of Hungary was carried out in essentially the same manner as the third survey. All plane table sheets of the cadastral survey were reduced with a pantograph, and were published on the Polyhedric Projection at 1:75,000 scale. From 1896-1898, three trig points were required per plane table sheet. From 1898 to 1903, 10 trig points per sheet were required, and that was increased to 20 trig points thereafter.

Tacheometry was introduced for this survey, and mapped distances could be estimated only if less than 100 meters from the instrument. In 1905, photogrammetry replaced the plane table with the stereo-comparator (sort of an un-digitized analytical plotter to you readers under 40).

In 1907, Dr. A. Fasching derived the position of the eastern tower of the former observatory at Gellérvár, where the Latitude of Origin (\( N_L \)) = 47° 29′ 09.6380″ North and with a Central Meridian (\( \lambda_c \)) = 36° 42′ 53.5733″ East of Ferro and \( \alpha = 100° 47′ 07″ \) to the Laplace station Széchenyihegy. In 1908, a system of three cylindrical projections was introduced, all with the Central Meridian of Budapest. The oblique cylinders touch the Gaussian sphere along the great circles perpendicular to the meridian at the following origins: 48° 42′ 56.3180″ North, 47° 08′ 46.7267″ North, and 45° 34′ 36.5869″ North. For the orientation, the azimuth Gellérvár- Széchenyihegy was used, hence the common X axis of the three cylindrical projections form an angle of 6.44 arc seconds with the Budapest Stereographic Grid of 1874. The stereo-

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the never completed Fourth Topographic Survey! The Zeiss 1911 Stereoautograph, photogrammetry used terrestrial photographs! The Zeiss 1911 Stereoautograph, the next wonder of photogrammetry, was used to compile the last sheets of the next wonder of photogrammetry, the Military Geographic Institute of Vienna allowed the compilation, in- cluding contours, to be done completely mechanically (as opposed to in-situ field work). Note that this phenomenal breakthrough in mapping with photographmetry used terrestrial photographs! The Zeiss 1911 Stereoautograph, the next wonder of photogrammetry, was used to compile the last sheets of the never completed Fourth Topographic Survey of the Austro-Hungarian Empire. According to Andrew Glusic of Army Map Service, (from 40+ years ago):

**Warfare and the Map.** The armies have been using the maps for more than two centuries. The Napoleonic Wars gave a special impulse to the use of geographic maps in warfare; consequently, in the European armies mapping services were created, of which many are known as Military Geographic Institutes. It was the military who through the XIX century in Europe as well as in the colonies was responsible for the largest part of the geodetic and topographic surveys. In these surveys the military aspects dominated; particularly at their outset the scientific purposes were not considered and many times also technical requirements were ignored. There was a goal to produce a military map. This military map should include all such information of the area concerned which the military leaders need for the planning and execution of movement, combat, accommodation and supply. The enormous technical progress in the last century largely influenced the application of strategic and tactical principles in warfare; therefore the nature of warfare changed and consequently the requirements for the military maps. In order to avoid the lack of adequate maps in any future war, the nature of the warfare together with the corresponding changes which would affect the standards of the mapping have to be considered in advance within limits of possibility and also proper measures should be undertaken at the time. The Austro-Hungarian military authorities passed up the proper time for such considerations; hence the single tactical map of the Monarch - 1:75,000 special map - trailed far behind the requirements imposed by the changes of warfare in World War I.

A new topographic survey of Hungary was started in 1927. The oblique stereographic projection was used for the “Budapest System” with the origin at the base point of the East Tower of the Astronomical Observatory of Budapest at Gellértgy. (The observatory was torn down and replaced by a stone fortress on Gellért hill. The old point was then later found to be on the rampart of that fortress, and a National Report to the IUGG portrayed a photograph of the point marked by a gazebo-like canopy!) The origin of the coordinate system was defined where: Latitude of Origin \( \phi_0 \) = 47° 29’ 09.6380” North, with a Central Meridian \( \lambda_0 \) = 36° 42’ 53.5733” East of Ferro (Ferro = 17° 39’ 46.02” West of Greenwich as derived from astronomical observations in 1907). The defining azimuth was from Gellértgy to Nagyszal where: \( \alpha \) = 191° 28’ 52.19” as retained from the 1874 datum values from Vienna University. The ellipsoid of reference was the Bessel 1841 where: the semi-major axis \( a \) = 6,777,397.155 meters and the reciprocal of flattening \( 1/f \) = 299.1528128. The False Easting and False Northing were each 500 km.

The northern part of Transylvania, occupied by the Hungarian Army in WWII, was mapped with a system defined as the “Marosvásárhely Stereographic System” with a Datum Origin point at the cadastral triangulation station Kesztej where: Latitude of Origin \( \phi_0 \) = 46° 33’ 09.12” North, and with a Central Meridian \( \lambda_0 \) = 42° 03’ 20.955” East of Ferro. The defining azimuth from Kesztej to Tíglamor was: \( \alpha \) = 146° 57’ 41.052”. The False Easting and False Northing were each 500 km.

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The national Datum of 1957 with the Grid parameters of a scale factor at origin equal to unity, and false origin 500 km West and 5000 km North. Since 1954, the Krassovsky 1940 ellipsoid was used where: the semi-major axis \( a \) = 6,378,245 meters and the reciprocal of flattening \( 1/f \) = 298.3. Prior to 1957, the Central Meridians \( \lambda_0 \) for military mapping were 18° and 21°, and after 1957, 15° and 21° were used. For cadastral mapping since 1957, the Central Meridians of 17°, 19°, 21°, and 23° were used. The Hungarian Datum of 1957 with origin coordinates at Erdőhegy and associated parameters were kept secret for military purposes.

The new national Hungarian Datum of 1972 (HD 72), also known as the “Unified National Horizontal Network of 1972” (EBOA Datum of 1972), is defined with origin coordinates at Szthelly where: \( \phi_0 \) = 47° 17’ 30.44” North, \( \lambda_0 \) = 19° 36’ 10.18” East of Greenwich. The defining azimuth is from Szthelly to Erdőhegy: \( \alpha \) = 209° 55’ 27.79”. The corresponding geodetic parameters of this origin are: \( \phi_0 \) = 47° 17’ 32.165” North, \( \lambda_0 \) = 19° 36’ 09.9865” East. The defining geodetic azimuth is: \( \alpha \) = 209° 55’ 26.64” and the ellipsoid of reference is the Geodetic Reference System (GRS) 1980. For the origin, \( h_0 \) = ellipsoid height, \( H_0 \) = height above the Baltic Sea and \( N_0 \) = geoid undulation. Therefore, \( h = 233.80 \) meters = \( h_0 + N_0 = 229.24 \) m. + 4.56 m. The published transformation parameters from HD-72 to WGS 84 are: \( dx = -5.3 \) m, \( dy = +157.77 \) m, \( dz = +31.6 \) m, \( k = -2.11 \) ppm, \( R_x = -1.11 \), \( R_y = 0.50 \), \( R_z = -0.97 \). Remember the Hungarian transverse cylindrical Grids of 1908 mentioned several paragraphs ago? Well, the new system is based on a new definition of that old Hungarian favorite.

The Egységes Orzágos Védelmi rendszer (Uniform National Projection System) “EOV Grid” is a conformal double transverse cylindrical projection. The Grid is defined at: \( \phi_0 \) = 47° 08’ 39.8174” North, Central Meridian, \( \lambda_0 \) = 91° 02’ 54.8584” East. The false origin is 200 km east (+X), 650 km north (+Y), and the scale factor is 0.99993. The fundamental national benchmark is at Nadap where \( H = +173.1638 \) meters above the Baltic Sea and \( H = +173.8388 \) meters above the Adriatic Sea.