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The Sputnik Gazette

Editorial

Dear Reader, the third issue of the Sputnik Gazette dives once more into history. One of the main ideas for the Global Positioning System (GPS) stems from observing the Sputnik I and II satellites. But before having a closer look at this story I'd like to advertise not only the International Sputnik Day 2007 website at http://sputnik.irmielin.org but also an additional blog, which collects information on all the official celebrations (not necessarily associated with ISD 2007) at http://internationalsputnikday2007.blogspot.com. This issue opens with a very short excerpt by the Russian futurist writer Velimir Chlebnikov from 1921 which I found interesting and relevant for this Sputnik Gazette.

Best regards, Your

Francis Hunger

The Future Radio

Let's appoach it closer... Proud skyscrapers drowning in the clouds, a chess game between two people on opposite points of the globe, a stimulated dialogue between a men in Amerika and a men in Europe... Now it became dark in the reading halls; and suddendly from a distance the song of a singer began to sound, with iron throats the radio transmitter threw the songs' rays to its iron vocalists. Sing, iron! [...] Every village will have listening devices and iron throats for this particular sense and iron eyes for the other.

Подойдем ближе... Гордые небоскребы, тонущие в облаках, игра в шахматы двух людей, находящихся на противоположных точках зем-ного шара, оживленная беседа человека в Америке с человеком в Европе... Вот потемнели читальни; и вдруг донеслась далекая песня певца, железными горлами Радио бросило лучи этой песни своим железным певцам: пой, железо! [...] В каждом селе будут приборы слуха и железного голоса для одного чувства и железные глаза для другого.

(Velimir Chlebnikov: Radio budušzego, 1921 – published in: Sobranie proizvedenij, Leningrad 1930)

Img: Velimir Chlebnikov, 1915

Sputnik and the Global Positioning System

The Sputnik had great influence on the development of GPS in two means: First of all it led to the political support for the military and scientific space program in the US on the administrative level. Following the „Sputnik shock" the Department of Defense (DOD), in parallel with other programs, enforced the research on a global, continuous available, all-weather, highly accurate navigation system, which resulted in separate programs of the US Navy and the Air Forces. And second: on a more individul level the beep sound of the Sputnik radio transmitter inspired US scientists to research one of the basic ideas of what would later become the Global Positioning System.

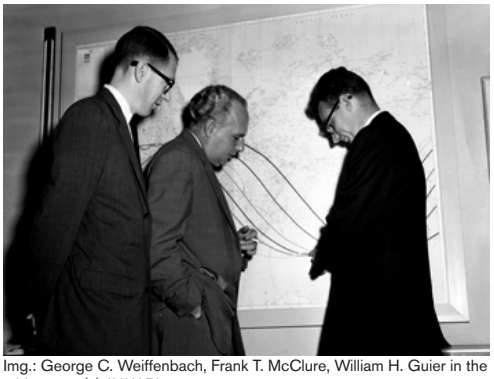
The Applied Physics Laboratory (APL) is a 1.450.000 sqm campus of the Johns Hopkins University, situated about 30 km north of Washington near the route 29 between Washington and Baltimore. It was and is deeply involved into research on military applications of physics.

William M. Guier and George C. Weiffenbach, both physicists at the APL, worked on a project to improve the beam rider system of Terrier and Talos anti-aircraft missiles during the 1950s. A beam rider is a laser or radar based early missile guidance system. So they both were into trajectories (flight paths of objects) and aerodynamics, issues which fueled the growing need in computing power during and after World War II. William Guier was also working on the SEAC computer at the Bureau of Standards, Washington. Participating there at project Matterhorn –the hydrogen bomb– he used the most recent computing equipment of the early 1950s.

The decision to receive and record Sputniks' signals was made according to Guier/ Weiffenbach in the cafeteria, when sitting around with colleagues and discussing the news of the Sputnik launch: „ We remember the widespread surprise that apparently no one had come to the Laboratory over the weekend and attempted to receive the signals. The more we discussed the issue, the more keen we became on listening in."(1)

To find the satellites path they did not track the satellite with a set of antennas using angle measurements as the majority of American institutions did. They just had access to a single antenna and compared Sputniks signal with another close-by signal source: Not far from the APL, just 20 kilometers away, the National Bureau of Standards' radio station broadcasted frequency and time standards, which they set in relation to the Sputnik signal. This limitation however fostered a unique solution to later shape one of the fundamentals of GPS. While listening to the satellites beep-sound, they recognized a change in the radio frequency. This frequency-shift is also known as the Doppler effect.

"We could positively identify our source as a near Earth satellite! Somewhat later that evening, we remembered that we could estimate the closest approach of Sputnik to our antenna by determining the maximum slope of the Doppler shift – a method APL used in estimating the distance of closest approach of a guided missile to its target. From that time forward, we focused increasingly on quantifying the Doppler data and inferring the satellite's orbit from the data."(2)



Img.: George C. Weiffenbach, Frank T. McClure, William H. Guier in the mid-1960s (c) JHUAPL

Now Guier and Weiffenbach began to approach the task of following Sputniks trajectory in a more structured way. They made recordings, put timestamps on it and started to digitize data and calculate it with APL's new UNIVAC computer. They also monitored the trajectory of Sputnik II (launched November 3, 1957) and the first American satellite Explorer I (launched January 31, 1958) and refined their methods until they could determine the position from only a single pass of the satellite. And then, on Monday, March 17, 1958 they presented the data and their conclusions to Frank T. McClure, their supervisor.

On Tuesday McClure send the following memorandum to the APL director Ralph E. Gibson: „Yesterday I spent an hour with Dr. Guier and Dr. Weiffenbach discussing the work they and their colleagues have been doing on Doppler tracking of satellites. During this discussion it occurred to me that their work provided a basis for a relatively simple and perhaps quite accurate navigation system."(3)

McClure reasoned that Guiers and Weiffenbachs solution of calculating the position of Sputnik has just to be turned around: If you know the satellite position, you can determine your own location on earth. It has to be mentioned that McClure was already aware of the need for a navigation system, which was especially being searched for by the US Navy for their Polaris nuclear submarine program. McClure and Richard B. Kershner wrote a proposal to develop a satellite based navigation system for the Navy, which evolved into the Transit satellite navigation system and this is not the end of the story but its beginning.

(1) Guier/ Weiffenbach: Genesis of Satellite Navigation, Johns Hopkins APL Technical Digest 2, 1997 (2) ibid. (3) McClure, Frank T. In: Johns Hopkins APL Technical Digest, v19, 1998, p7