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## Tools Telling Time – Lecture 1: Sundials And Hormones: A Biologist's Perspective

Concepts: time, solar system, light, seasons, adaptiveness

Where is the world's largest sundial today? With 38.33m in diameter, it is located in the Torne Valley, north of the Arctic Circle, dedicated to the Midnight Sun. The architect Mats Winsa designed the 'sun wheel' as a calendar with the gnomon in line with Earth's axis pointing to the Polar star, which, according to Finish-Ugrian mythology, holds up the firmament.

We live on Earth, a planet-bound by gravity to the sun. The sundial tells solar time from the predictable near-24h rotation of Earth upon its axis. But there is a catch: Daylight hours are not uniformly distributed across time and space – instead, daylight length varies due to Earth's axis being tilted. Daylength becomes longer and shorter, giving us pronounced seasons in the Nordic countries, not only in daylight availability but in solar energy. The evolution of life in the North is dominated by these predictable daylight changes and energy constraints, and physiological and behavioral characteristics of organisms adjust in very significant ways.

While our solar system is the number one timing system, there is a second timing system. It arises from within our body. An endogenous biological clock made up of brain tissue generates an imprecise rhythm in neuronal activity of nearly 24 hours. This clock requires a daily adjustment so that internal time coincides with solar time, and when aligned, physiology adapts in anticipation of the daily and seasonal demands arising from local habitats. The critical agent (cue, zeitgeber) required for the body clock's adjustment is the change of solar radiation at dawn and dusk. Humans use their eyes to capture natural light levels on a daily basis, and at very low levels, the pineal gland secretes the hormone melatonin into the blood and cerebrospinal fluid. Melatonin's orderly rise and decline from one night to the next reveals the direction of seasonal transition, which acts as a forecast for the physiology to adapt in anticipation of seasonal change.

In this lecture, we focus on delineating the biogeographic topography and different tools and evolutionary adaptations specific to the Nordic region with its constraints by the durations of time that are illuminated by daylight, moonlight and/or twilight and thermal limits. This part is followed by lecture 2 - Sundials and Hormones: A Designer's Perspective on how this knowledge can be utilized in various forms and ways to enrich the design process from an early planning stage.