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The day of the European Surveyor and GeoInformation
22 March 2013

Galileo Galilei

Introduction

For a second consecutive year, the Council of European Geodetic Surveyors has decided to organize the Day of the European Surveyor and GeoInformation. The celebration took place on 22nd March 2013, in Budapest, Hungary, during the first CLGE General Assembly of the year. Moreover, many other festivities were held throughout the European capitals by CLGE member organizations, from 16 to 24 March 2013. On 18th March 2013, a reception was organized in Europe's Capital Brussels, in the House of the European Surveyor and GeoInformation, in presence of distinguished guests, including the President of the Belgian House of Representatives, André Flahaut, the President of the European Ecomomic and Social Committee, Henry Malosse, the President of EuroGeographics, Ingrid Vanden Berghe.


André Flahaut, President of the House of Representatives of the Belgian Kingdom

On this 22nd March 2013, CLGE has announced who would be the European Surveyor of the Year, to be honoured until the next celebration in March 2014.

This time, Galileo Galilei [we use the Italian spelling on purpose] was declared European Surveyor of the year 2013. He follows Mercator, European Surveyor in 2012, honoured during the first Day of the European Surveyor and Geo-Information by CLGE, in the presence of Cheehai Teo, FIG President.

On 21st March, on the eve of the Surveyors Day, the poster of Galileo Galilei was unveiled to the general public. This took place in the European Space Expo that was organized in the Hungarian capital in a joint effort of the European GNSS Agency GSA, CLGE and the local Hungarian umbrella of Surveyors'Associations.

Rudolf Staiger, FIG Vice President represented his organisation, in presence of John Hohol, President of the FIG Foundation. The latter also represented the National Society of Professional Surveyors from the USA (NSPS). The FIG Young Surveyors Network has sent its Secretary Eva-Maria Unger.

CLGE joined by NSPS have decided to promote the creation of a worldwide Surveyors' Day.

This was confirmed in the Budapest Declaration, signed by John Hohol for NSPS, Gyorgy Domokos, delegate to CLGE for the Hungarian Umbrella Organisation and myself. The Budapest Declaration is showed hereafter.

Henri Malosse, incoming President of the EESC

It is followed by a text prepared by the CLGE delegate and Secretary General of the Italian Consiglio Nationale di Geometri e Geometri Laureati, Enrico Rispoli, reminding us the life and work of our illustrious predecessor, Galileo Galilei. We thank him and Maria GraziaScorza for this work, as well as Muiris de Buitleir and Judith & Maurice Barbieri for their proofreading.

A film produced by Enrico Rispoli will be available on-line soon.

All this wouldn't be possible without the support of our partners and sponsors. In the name of CLGE I want to thank them sincerely. A special mention is due to Omar Pierre Soubra from Trimble who has committed his company as primary sponsor for these events. We of course thank Steven Berglund, President and CEO of TRIMBLE as well as the entire company.

I seize the opportunity to thank Marie Ménard and Reinhard Blasi, from the European GNSS Agency GSA, and our Hungarian delegate Gyorgy Domokos as well their respective teams for the excellent work they did in preparation of the European Space Expo and our General Assembly. My gratitude goes also to all the CLGE delegates who've celebrated this Day in their own way.

Jean-Yves Pirlot
CLGE President

Budapest Declaration

The honourable and historic profession of surveying has been in existence since the beginning of civilisation. Surveying is recognised as the world's oldest legal profession.

From the rope stretchers of ancient Egypt into modern society the surveyor has been an essential foundation in civilisation's development. He's qualified and ready to take the same responsibilities in the future.

Whether on land, in water or space, surveyors are always at the forefront.

In recognition of the essential role surveyors play in all phases of today's world and to honour and publicise the surveying profession and the important work done by surveyors we hereby declare:

22 March 2013 as SURVEYOR'S DAY

Moreover, we ask the international Surveyors Federation, FIG, to consider the creation of a common worldwide Surveyor's Day.

John Hohol
Representing Robert Dahn, President of
The National Society of Professional Surveyors
USA

Jean-Yves Pirlot
CLGE President

Europe

Gyorgy Domokos
CLGE Delegate for the Hungarian Umbrella

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Galileo Galilei

Galileo Galilei *was an Italian physicist, mathematician, astronomer, and philosopher of the sixteenth century who played a major role in the Scientific Revolution.*

"Philosophy is written in that great book which continually lies open before us (I mean the Universe). But one cannot understand this book until one has learned to understand the language and to know the letters in which it is written. It is written in the language of mathematics, and the letters are triangles, circles and other geometric figures. Without these means it is impossible for mankind to understand a single word; without these means there is only vain stumbling in a dark labyrinth."

In this sentence we find the key to Galileo's beliefs. His researches and discoveries are the basis of modern physics, the global geo-referencing system and the satellite technology for our planet.

His Life

Galileo Galilei was born in 1564 in Pisa, Italy, where he studied mathematics. He started taking private instruction in mathematics from Ostilio Riccia a former student of Niccolò Tartaglia, one of the most famous mathematicians of the sixteenth century**.** In 1589 Galileo held the chair of mathematics in Studio di Pisa and in 1590 he wrote "De motu" concerning the theory of motion.

From 1592 to 1610 he lived in Padua, where he taught mathematics and wrote about military architecture and physics. In Padua, Galileo met the Aristotelian group of Padua and some exponents from Venice. As a defender of Copernican ideas, considered heretical in 1612, Galileo was denounced to the Holy Office and in his defence he wrote a letter to Cristina di Lorena Medici, mother of the Grand Duke of Tuscany, in which he explained that the Bible deals with moral and religious topics and not scientific problems and for this reason science is not in opposition to the Bible.

In 1616 the Holy Office condemned the Copernican theory and Galileo was 'invited' not to support it in his works.

Galileo then wrote about the Copernican theory as a mathematical hypothesis without commenting on the contradictions between this theory and the accepted Earth centre theory. However, his personal ideas on the Copernican theories were so clear that his enemies denounced Galileo yet again.

Thanks to the use of the telescope Galileo was able to show that the Copernican theory was not simply a geometric hypothesis but was a physical reality, and that the sun does not circle the earth but the earth circles the sun.

The Holy Inquisition started a case against Galileo, who in the end was compelled to admit that he was wrong. In order to save his life he was forced to recant.

Galileo was allowed to return to his villa in Arcetri near Florence in 1634, where he spent the remainder of his life under house arrest. However his daughter Maria Celeste freed him from this burden after securing ecclesiastical permission to accept house arrest in his place**.**

In 1638 he wrote *Discourses and Mathematical Demonstrations Relating to Two New Sciences* and in 1642 he died.

Galileo's discoveries were very important and formed a worthwhile contribution to modern physics leading to the decline of the Aristotelian theory.

Religion

Galileo had always declared that religion and science could coexist, because religion deals exclusively with moral topics.

Galileo's revolutionary discoveries

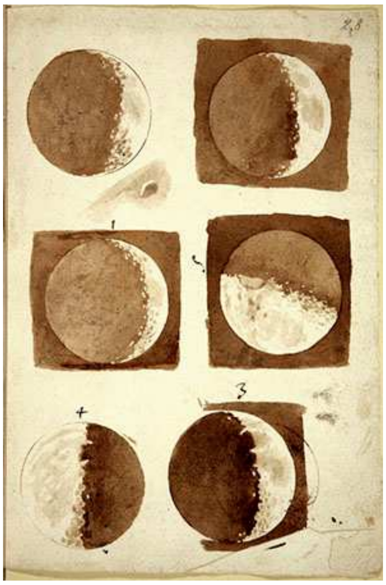
The telescope (spyglass)

During a vacation in Venice in 1609 Galileo became aware of a device, invented by a juggler, by which, through looking through a pair of glass lenses mounted in a tube, distant objects appeared to be much closer (a spyglass).

Galileo Galilei created his own spyglass. After 24 hours of experimentation using only his own intuition and verbal descriptions (he hadn't actually seen the juggler's invention!) he created a spyglass capable of three magnifications. After some further modifications his invention achieved an enlargement power of X10.

In Venice he showed the capabilities of his invention to an astonished Senate.

Galileo's great insight was to create a synergy between theoretical science and practical technique. Thanks to the invention of the spyglass, or telescope, he could observe the stars and planets with greater clarity and precision than was possible up to then.



Galileo Galilei - Lunar phases

Galileo observed the Moon with the telescope, which revealed sunrise and sunset on the Moon. With the half Moon partially in light and darkness he was able to observe the mountains on its surface.

Till then people believed that the Moon was a plane sphere of white crystal. His 6 watercolour works show other important discoveries developed in the *Sidereus Nuncius*, where he describes that the moon's surface consists of valleys, plains and mountains much like the surface of the Earth.

Subsequently he observed the phases of Venus. One of his first discoveries was the presence of small bodies orbiting around Jupiter, which he called the Medicean satellites in homage to the Medici family. The fact that the satellites of Jupiter patently orbited the planet itself and not the Earth gave a clear indication that the Aristotelian thesis of an Earth centred universe was suspect.

This provided an important support to the Copernican theory of a solar system in which the Earth orbited around the Sun, and the Moon, in turn, orbited around the Earth, contradicting Aristotle's theory that the Earth was the centre of motion and that all heavenly bodies revolved around it. Another innovative observation came from viewing the Milky Way. With the help of the telescope he saw that the Milky Way was composed of individual stars and he deduced that these stars couldn't all lie at the same distance from Earth as the familiar fixed stars of the night sky, as asserted by Aristotle.

Galileo also observed sunspots. In Galileo's opinion sunspots were dark regions of variable and irregular shape on the surface of the sun. The fact that the surface of the sun was irregular and that its aspect changed over time was evidence that the Ptolemaic theory (immutability and perfection of the celestial bodies) was wrong.

The Isochronism of the Pendulum

Galileo was interested in a mathematical approach to the question of motion.

From an early age he began to analyse and criticise the Aristotelian physics he had studied and preferred to take the route of direct experimentation. We know Galileo began studying pendulum motion in 1581 after he had observed the oscillation of a lamp in the Cathedral of Pisa.
Galileo realised that the period of oscillation of the pendulum was independent of its range of swing (Isochronism of the Pendulum) and he attempted to find the relation between the length, weight and period of the pendulum. He wanted to know the duration of the lamp swings, and to this end, he measured the period of oscillation of both large and small lamps.


Galileo discovered something that no one before had never realised: the period of oscillation was exactly the same for all the lamps. The pendulum could be used to measure intervals of time and be applied, for example, in the medical field to measure the pulse rate of the heart.

In 1641 Galileo proposed the use of the pendulum as mechanism to regulate clocks.

This rule of the pendulum, that could then be used to measure time and regulate clocks, made him instantly famous.

Hydrostatic Balance

In 1586, Galileo wrote a short work on the method of measuring precious metals in a more precise way. He designed a device called a hydrostatic balance, which simplified measurement.

Galileo's balance (Little Balance – Bilancetta) was a system composed of a lever: an arm with the counterweight which was bound with metallic wire. The movement of the counterweight along the fulcrum could be measured counting the number of rounds of the metallic wire along the arm. Galileo built his "little balance" first in 1608.

Thermoscope

At the beginning of the seventeenth century Galileo created the thermoscope in order to measure the temperature of a body. The thermoscope was a device composed of a bulb with a long, thin neck, filled with air, inserted in a tank of water. When the bulb heated, there was an expansion of the air and the water level became lower, on the other hand, when the air cooled the volume of the air reduced and the water level rose and was visible in the neck of the bottle. With some friends Galileo continued to study the thermoscope. He refined the instrument by adding a numeric scale and thus created the first air thermometer.

Geometric and Military Compass

MISVRAR CON LA VISTA. 26

ET volendo noi misurar un'Altezza, la cui radice nõ si uedesse, come saria l'Altezza del monte A B. sendo nel punto C. traguarderemo la sommità A. notando i punti I. tagliati dal perpendicolo D I. i quali siano, per essempio, 20. di poi accostãdoci verso il monte 100. passi innanzi, venẽdo nel punto E. traguarderemo l'istessa sommità, notando i punti F. i quali siano 22. il che fatto deuonsi multiplicare trà loro questi due numeri 20. & 22. fanno 440. & questo si diuida per la differenza delli medesimi numeri, cioè per 2. ne viene 220. & tanti passi diremo esser' alto il monte.

Il compasso si trouerà sopra lo Strumento pigliãdo il minor numero de i punti tagliati, rettamente sopra le linee Aritmetiche, & applicandolo poi trasuersalmẽte alla differenza delli due numeri de i punti, pigliando in oltre trasuersalmente l'altro numero de i punti il quale misurato rettamente ci darà l'altezza cercata: come se, per essempio, i punti tagliati fussero stati 42. & 58. preso 42. rettamente, buttisi trasuersalmente alla differenza de i detti numeri, cioè al 16. ò, non potendo, al suo doppio triplo quadruplo, &c. Sia al quadruplo, che è 64. & preso poi il 58. ò il suo quadruplo cioè 232. & misurato rettamente ci darà 152. e un quarto, che è il proposito.

Posso-

Galileo Galilei, Geometric and Military Compass, about 1606

Galileo invented the proportional compass, an important instrument for the end of the sixteenth century. This device can be considered “the first instrument of calculation in history, apparently simple, but capable of carrying out mathematically and geometrically complex operations”.

Galileo described the instrument, which he had created in cooperation with his co-worker Marcantonio Mazzoleni in 1597, in the work “Operations of the geometric and military compass” published in Padua in 1606 and dedicated to Cosimo II.

The geometric and military compass facilitated the solution of mathematical and geometrical operations with greater speed and ease than was possible heretofore. It was useful for civil and military purposes.

With the help of this compass it was possible to measure distances, heights, depths and slopes, the ballistics of artillery and it was possible to draw new maps using a different scale. Finally it permitted also to calculate money exchange and interest rates.

The instrument was composed of two rulers of the same length, attached with a disk that allowed them to open and close like a compass. On the two rulers there were seven proportional scales (arithmetic, geometric, stereometric, tetragonic, polygraphic, etc.) and a graduated arc with a degree scale and scale of slopes. The instrument had its origin in Euclid’s theorem.

Thanks to the seven scales on the legs of the compass it was possible to solve all the arithmetic and angular problems in the abacus tradition.

Other scales inscribed on the arc transformed the compass into a gunner’s or astronomical quadrant.

The compass was also the first practical clinometer used for land surveying.

Galileo Galilei’s extraordinary practicality

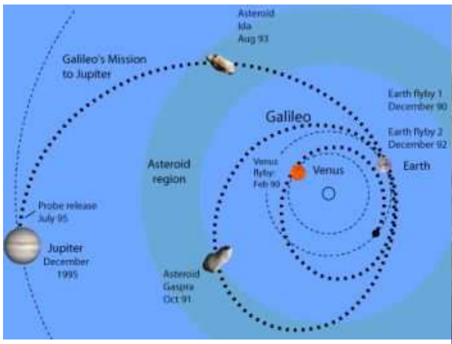
On January 7, 1610 Galileo turned his 30 power telescope towards Jupiter, and noticed three small, bright stars near the planet. One was off to the west, the other two to the east, all three in a straight line. The following evening, Galileo once again took a look at Jupiter, and found that all three "stars" were now west of the planet, still in a straight line! Galileo continued his observations, over several years, of the movement of the satellites of Jupiter and listing the moment of their occultation behind or in front of the planet relative to time. This ephemeris could be used for navigation at sea, giving a ship’s captain an effective celestial clock. However, holding a 30 magnifications telescope steady enough on a lurching ship’s deck to allow such an observation to be made was an entirely different matter!

Application of Galileo’s inventions

Many of the most important space initiatives of recent times take the name of Galileo Galilei(or Galilee) as a way of paying homage to one of the fathers of astronomical discovery and one of the earliest exponents of the value of scientific methodology and recording.

The NASA spacecraft, launched and carried by Space Shuttle Atlantis on the 18th of October 1989, to study Jupiter was called Galileo.

The spacecraft carried out studies of Jupiter and its moons and an atmospheric probe from this spacecraft gave the first direct information about the composition of this planet. On its way to Jupiter, Galileo sent images of two asteroids to the Earth, 951 Gaspa and 243 Ida and from its privileged viewpoint above its surface; Galileo was able to record images of the impact of the comet SL9 on Jupiter.



Galileo arrived at the orbit of Jupiter and thanks to a special trajectory called "V.E.E.G.A." (Venus - Earth - Earth Gravity Assist), it started its actual mission only six months after its departure from Earth.

From the first moment Galileo’s contribution to human knowledge was very important because of the extraordinary images which it sent back to Earth. The most important part of the mission happened in July 1995 when Galileo sent a probe, a capsule that, before being pulled into the fatal gravitational power of the planet, carried out mapping, sending back data for 58 minutes.

Satellite navigation – Galileo

“Galileo” is also the well-known name of the Project of the European System of Satellite Navigation, so named to pay homage to Galileo and his system using the Jovian satellites which marked one of the earliest initiatives in modern astro-navigation.

“Galileo” will ensure Europe's independence in a sector that has become critical for its economy and the well-being of its citizens.

GALILEO

It is worth noting that it is not only the United States (GPS) who has constructed its own GNSS (global navigation satellite system). Other countries are also developing their own GNSS and it is important that Europe should not be left out in the cold. It would be a highly undesirable scenario if European business were unable to benefit from the multiple economic, environmental, innovative, research and employment opportunities offered by Europe having its very own satellite navigation system.

Europeans have become so dependent in their daily lives on services provided by satellite navigation that should a service be reduced or switched off, the potential disruption to business, banking, transport, aviation, communication etc., to name but a few, would be very costly in terms of revenue losses for business, road and aviation safety etc.

With Galileo, Europe is also able to exploit the opportunities provided by satellite navigation to a much greater extent than would otherwise be possible. Galileo will help Europe more and more to maintain and develop its know-how in the space and applications sectors, securing revenues and jobs. Independent surveys and market forecasting indicate that, in addition, new applications which make transport more effective, lead to better road management, cause traffic to be less polluting and rescue operations to be more effective, are worth up to 90 billion euros over the first twenty years of operation.

The combination of Galileo and GPS signals in dual receivers will open the door to new applications that require a higher level of precision than is currently available with GPS alone. This includes for example applications to guide the blind, to increase the success rate of rescue operations in the mountains, to monitor the whereabouts of people suffering from Alzheimer's disease, etc. In addition, Galileo will improve the overall availability and coverage of GNSS signals.

Galileo in short: precision, availability, coverage

Precision: Using a combination of GPS and Galileo (compared to GPS alone) the higher number of satellites available to the user will offer higher precision. From most locations, six to eight Galileo satellites will be visible which, in combination with GPS signals. This will allow positions to be determined within a few centimetres.

Availability: The high number of satellites will also improve the availability of the signals in high-rise cities, where buildings can obstruct signals from satellites that are low on the horizon.

Coverage: Galileo will also provide a better coverage at high latitudes than GPS, thanks to the location and inclination of the satellites. This will be particularly beneficial for Northern Europe.

Who is involved?

The definition phase and the development and In-orbit validation phases of the Galileo programme were carried out by the European Space Agency (ESA) and co-funded by ESA and the European Union.

The fully operational capability phase of the Galileo programme is fully funded by the European Union and managed by the European Commission. The Commission and ESA have signed a delegation agreement by which ESA acts as design and procurement agent on behalf of the Commission.

Galileo services definition

The Galileo mission and services have been developed during the initial definition phase, in consultation with user communities and the Member States.

The services which Galileo will provide are as follows:

Open Service: basic signal provided free-of-charge;

Commercial Service: combination of two encrypted signals for higher data throughput rate and higher accuracy authenticated data;

Public Regulated Service: two encrypted signals with controlled access for specific users such as governmental bodies;

Search and Rescue Service: Galileo will contribute to the international COSPAS-SARSAT cooperative system for humanitarian search and rescue activities. Each satellite will be equipped with a transponder which will transfer the distress signal from the user to the Rescue Coordination Centre and inform the individual in distress that his situation has been detected.

Galileo Architecture

The full Galileo infrastructure will be composed of:

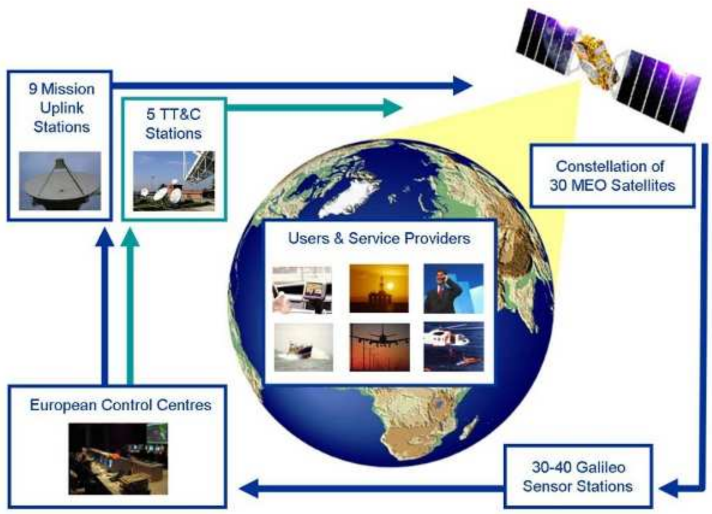
A constellation of 30 satellites in Medium-Earth Orbit (MEO). Each satellite will contain a navigation payload and a search and rescue transponder;

30-40 sensor stations;

3 control centres;

9 Mission Uplink stations;

5 telemetry, tracking and command (TT&C) stations.



The introduction of GALILEO will lead to greater reliability and an effective guarantee of service. It will also considerably improve the authentication of the signal and the integrity and transparency of operation. It will also provide the possibility to manipulate raw or processed data and increase the overall accuracy of the system.

In addition to all these features, the GSA (GNSS Agency) and the Galileo Concessionaire will create an institutional framework that will regulate and help the diffusion of Galileo on the global market. Day by day we see new possible applications and this enormous market will reach 3 billion users by 2020.

Enrico Rispoli – Segretario
Consiglio Nazionale
Geometri e Geometri Laureati