THE DOPPLER ECHOGRAPHY – FROM GREEK MYTHOLOGY TO MODERN CARDIOLOGY

Diana DĂNIŞOR[*], Octavian ISTRĂTOAIE[**]

Abstract: The following pages shall demonstrate how the nature of things is made evident through the science of naming, the structure of designation. Through this extensive analysis, I aim at establishing the connection between Greek mythology and modern cardiology by exploring the origin of the word *echography* and its modern counterpart *the Doppler echography.*

Keywords: echo, echography, Doppler echography, Greek mythology, Cardiology.

ECHO GREEK MYTHOLOGY

The word "echography" originates from the Greek mythology nymph Echo, nymph of the forests and springs of Mount Helicon, the very personification of the acoustic echo. In the Ancient Greek language, Ἠχώ / *Êkhó*, she was an oread raised by nymphs who was prone to prolixity and exacerbated playfulness, constantly making up wild stories, talking incessantly to distract Hera, as she favoured Zeus' many erotic indiscretions. The jealous Hera becomes aware of her trickery and curses Echo to never again be able to be the first one to speak, but rather be content in repeating that which others have said[1]: "You will always have the last word, but you may never have the first"[2].

Echo is the unhappy heroine of two legends. Hidden in the depths of forests, her voice always answers to the voice that beckons; yet nobody can see her, only sound still lives inside her[3]. Rejected by her and jealous of her many talents, Pan

[*] Associate Professor, PhD., University of Craiova, Faculty of Law; E-mail: danisordiana@yahoo.ro

[**] Associate Professor, PhD., University of Medicine and Pharmacy of Craiova, Faculty of Medicine; E-mail: droctavist@yahoo.com

[1] Joseph Lœwenstein, *Responsive readings: versions of Echo in pastoral, epic, and the Jonsonian masque*, Yale University Press, 1984.

[2] Edith Hamilton, *La mythologie: ses dieux, ses héros, ses légendes*, Col. Marabout, Hamilton Publishing, 1997.

[3] Ovide, *Metamorfphoses*, Livre III, Trad. and notes de A.-M. Boxus et J. Poucet, Bruxelles, 2006, p. 400.

Anuarul Institutului de Cercet. Socio-Umane „C.S. Nicolăescu-Plopşor", vol. XVII, 2016, pp. 295-300

drives the shepherds against her and this will see her bones crushed and spread all over the earth. Gaia, Mother Earth, collects the broken parts of her body which still carried the power to repeat the last words of an utterance. Ever since, Echo has been omnipresent, and even in death her voice can still be heard.

Another legend depicts echo as being in love with the beautiful and lonely Narcissus. Cursed by Hera, she would follow Narcissus everywhere, but could not speak a word to him in order to confess her love. One day, while on the verge of successfully confessing her love, he brutally rejects her, a fact which leads to her doom, falling victim to profound sadness, she is torn asunder inside, losing so much weight until nothing of her remains except the voice that echoes in the mountains, repeating the last words of a phrase. A furious Artemis decides to punish him: one day, as he was coming back from a hunt, he stopped to cool off from a spring, falling in love with his own reflection in the water. Overwhelmingly mystified by the being he saw reflected in the water, he desperately tries to embrace his own image, being incapable of detaching himself from self-contemplation[4]. Faced with such burning passion, he chooses the path of suicide. An alternate version says that Narcissus was so obsessed with admiring his own reflection, that in his attempt embrace it, he fell into the water and drowned. Ever since then, the white daffodil flowers appeared upon his disappearance. The nymph Echo is sadly gone, leaving behind only a voice. The physical and acoustical phenomenon which shares her name was granted to honour the memory of the unfortunate nymph[5].

The dictionaries of the Romanian language attest the word by making reference to the ancient nymph only in the area of musical dictionaries[6]:

Echo (‹ gr. ἠχώ, from the name of the nymph Echo, "sound")

I. An acoustic effect produced by the reflection of a sound encountering an obstacle (surface, wall, rock, edge of forest) and perceived with a tiny delay by the emitter of the original sound. The delay must be at least 0.1 s long for the perception to be clear. Because the speed of sound is about 340 m/s, that would mean the soundwave must cross a minimum distance of 34 meters back and forth, so that the distance between the emitter-receiver and the obstacle must be at least 17 meters long.

II. The musical manual* for organ* encompasses a registry **(1)** of sound encountered in the registries of other manuals.

III. (it. *eco*; fr. *écho*; engl. *echo*; germ. *Echo*; sp. *Echo*)

Compositional procedure consisting of the repetition of a short theme* or a musical motif* of lower acoustic intensity*. It was widely used ever since the 15th

[4] Idem, *Légendes thébaines: Narcisse et Écho*, in "Metamorfphoses", Livre III, Trad. and notes de A.-M. Boxus et J. Poucet, Bruxelles, 2006, pp. 402-461.

[5] Yves Denis PAPIN, *Connaître les personnages de la mythologie*, Paris, Éditions Jean-Paul Gisserot, 2003.

[6] *Dicţionar de termeni muzicali,* Bucharest, Encyclopedic Publishing, 2010.

and 16th century in polyphonic vocal music by composers such as Josquin Desprez, Luca Marenzio and Orlando di Lasso (in the famous villanelle*, *Echo*, 1581), as a special imitational technique. In the 17th century, the first stage of artistic development, brings forth an avalanche of pastoral themes in which we often see the mythological figure of Echo weeping over unrequited love; and from this originated countless arias* using the **e.** procedure, a procedure that will be extended to works which do not share a connection with the legend. Remaining an independent musical procedure, the echo will be harnessed in the instrumental writings of the entire Baroque* period, seeing this dominant manner of repetition implemented both in the piano* and in the forte*. The procedure is used in concerto or responsive works as a special effect (Stamitz, Symphony in E flat major – "Echo Symphony", Mozart, *Notturno for 4 orchestras;* Chabrier, *España;* Rimski-Korsakov, *Spanish Caprice;* Strauss, *Ariadne auf Naxos*), or as a general principle of composition (Hindemith, *Echo for flute and piano*), commonly targeting stereophony*.

THE DOPPLER ECHOGRAPHY

Originating from the word *echo*, medicine creates the term *echography* – from êkhô + graphein (to write), has the following dictionary definition:

Echography n. (med.) An ultrasound method of medical diagnosis: ◊ "To be able to see one's child before it is born […], what can be more exciting for an expecting mother? This is possible today through the use of **echography** […]" Sc. 6 I 80 p. 5. ◊ "The writing of a volume of great scientific and practical value, « Medical *echography* », the first study of its kind in the country, and one of the few of its kind in the world. The volume […] describes and illustrates the *echography* of all the organs and systems pertinent to the use of relevant methodology in medical investigations". R.l. 5 X 82 p. 2. ◊ "Ultrasound **echography** will develop rapidly in the following years reaching a level of applying ultrasound diagnosis in all the fields of medicine […]" R.l. 17 V 84 p. 6; v. and *biomedical, echo graphic* (from Fr. *écographie;* PR 1972, DPN 1983; DN3, DEX-S)[7].

Echography (fr.) n. Method of exploring the living structures of organisms with the help of ultrasound reflection, which measures the depth and placement of these structures (simple echography) and obtaining images of their forms (echo-tomography). A variety of diagnosis techniques are used in neurology, ophthalmology, obstetrics, cardiology, urology, in pulmonary, liver and gastric diseases[8].

[7] Florica Dimitrescu, *Dicţionar de cuvinte recente,* Edition II, Bucharest, Logos Publishing, 1997.

[8] Marcel D. Popa, Alexandru Stănciulescu, Gabriel Florin-Matei, Anicuţa Tudor, Carmen Zgăvărdici, Rodica Chiriacescu, *Dicţionar enciclopedic*, Bucharest, Encyclopedic Publishing, 1993-2009.

During the 1940s, doctor George Ludwig[9] uses ultrasound for medical purposes on the human body for the first time. The next to follow in his footsteps is John Wild[10] (considered by many "the parent of medical ultrasound") who, in 1949, uses the procedure to estimate the thickness of intestinal tissue. Inge Edler and Carl Hellmuth Hertz (son of Nobel prized winner, physicist Gustav Ludwig Hertz) uses medical ultrasonography in Sweden, at the University of Lund, their team managing in 1953 to perform the first measurement of cardiac activity with the aid of ultrasounds, a method which facilitated the performing of an echoencephalogram[11]. The first application of this method in diagnosis is performed by a team led by professor Ian Donald in Scotland[12]. The commercial version of a device for measuring blood vessels pulsations belongs the Japanese physicist Shigeo Satomura[13].

The Doppler echography owes its name to Austrian mathematician and physicist Christian Andreas Doppler, famous for the discovery of the Doppler effect. The Doppler effect designates the delay in the frequency of a wave (mechanics, acoustics, electromagnetics or other fields) observed between the measurements of the emission and the reception when the distance between the emitter and the receptor varies in time. This effect was presented by the aforementioned scientist in 1842 in the famous article *Über das farbige Licht der Doppelsterne und einige andere Gestirne des Himmels*[14].

The Doppler is a medical apparatus based on the Doppler effect: the echography machines emit the ultrasounds towards the internal organs, recapturing the ultrasounds and processing them in order to offer images of the areas analysed[15].

In 1958, the continuous wave Doppler allows the study of blood vessels circulation. The first pulse wave Doppler is introduced in 1970 by Backer. The Doppler echography allows the analysis of blood circulation speed in order to calculate its flow. In cardiology, the tissue Doppler allows the analysis of the contraction speed of heart muscles (TDI = « Tissular Doppler Imaging »).

---

[9] Dr. George D Ludwig – pioneer in medical ultrasound. For more detalies, see http://www.ob-ultrasound.net/ludwig.html.

[10] Échographie Doppler, https://fr.wikipedia.org/wiki/%C3%89chographie_Doppler

[11] Siddharth Singh, Abha Goyal, *The Origin of Echocardiography. A Tribute to Inge Edler*, in "Texas Heart Institute Journal", no. 34(4)/2007, pp. 431-438.

[12] Ian Donald, *Investigation of Abdominal Masses by Pulse d'Ultrason*, Lancet, 1958, pp. 1188-1195, available at http://www.ob-ultrasound.net/lancet.html

[13] F. Picard, *Échographie et insuffisance cardiaque*, 2011, available at http://www.cardiologie-pratique.com/journal/article/13e-journees-d-echo-doppler-de-bordeaux-i-echographie-et-insuffisance-card iaque

[14] M. Moigno, *Repertoire d'Optique Moderne*, Vol. 3, Sur la lumière colorée des étoiles doubles, Paris, A. Franck, 1850.

[15] For detalies, see http://www.romedic.ro/dopplerul-cardiac-ecografia-cardiaca-doppler-0F27070.

The Doppler echography is a non-invasive procedure that does not require penetrating the skin barrier, thus avoiding the risk of infection, it is painless and non-traumatic, ultrasounds do not pose any danger for tissues. Being harmless to the human body, this apparatus can be therefore used repeatedly for as many times as needed.

The physical principles which contribute to the increase of practical utility are based on the fact that the ultrasound waves can be directed as a single beam, which can be later focused towards a single spot, offering an even greater precision and accuracy[16]. When crossing a particular environment, it submits to the laws of reflection and refraction of that environment, adapting to the density of the environment it intersects with, and finally it can accurately evaluate small targets, previously undetectable until the apparition of ultrasounds because ultrasound waves are reflected by that target, and can be later captured, amplified and analysed. The quantity of the reflected, refracted and controlled waves depends on the acoustic properties of the environment through which they propagate, gaseous environments cannot therefore be analysed through ultrasounds, while solid environments will reflect the vast majority of waves[17].

Soft tissues and blood allow the propagation of a large quantity of ultrasounds by increasing their penetration capacity, thus generating a vast utilisation potential of the method[18]. The higher the transmission of the ultrasound wave is, the higher the chances to detect small targets, but high frequencies have a reduced penetration capacity compared to low frequencies, so therefore, there is a loss in the percentage of the ultrasound waves which propagate in a given environment[19], a phenomenon called attenuation.

The purpose of a correct and extremely precise examination is to obtain the high speeds of low-frequency waves which facilitate the Doppler exchange defined as the difference in frequency of the transmitted signal compared to the one received called *grosso modo spectral analysis*[20], providing the essence of this method.

---

[16] N. Grenier, M. Claudon, *Bases physiques du Doppler*, available at http://www.sfrnet.org/rc/org/sfrnet/htm/Article/2011/20110524-112842171/src/htm_fullText/fr/polyBases Physiques_07.pdf

[17] Ch. Tegeler, F.W. Kremkau, L.P. Hitchings, *Color Velocity Imaging: introduction to a new ultrasound technology*, in "Journal of Neuroimag", no. 1(2)/1991, pp. 85-90.

[18] O. Bonnefous, P. Pesque, *Time domain formulation of pulsed Doppler ultrasound and blood velocity estimation by cross correlation*, in "Ultrasound Imaging", no. 8(2)/1986, pp. 73-78.

[19] S.G. Carlier, *A Clinician's Contribution to Biomedical to Engineering in Experimental Echocardiograpy*, Rotterdam, Erasmus University Rotterdam, 2001.

[20] Guy Van Camp, M. Menassel, D. Plein, B. Cosyns, S. Carlier, J.L. Vandenbossche, *Automated cardiac output measurement using color Doppler velocity profiles obtained with the multibeam Doppler method: in vivo validation in the intensive care unit*, in "Belgian Society of Cardiology", Brussels, 1997.

CONCLUSION

It would seem that the form words hold is endowed with individual purpose, a fact confirmed by this study resulting that the science of naming must be firmly anchored in the very nature of designation and purpose, and that man is not the crafter of names, but rather a willing spectator gazing at the natural dimension of each object, able to encompass form in the letters and syllables provided[21].

[21] Platon, *Cratylos*, in "Opere III" (translate by Simina Noica), Bucharest, Scientific and Encyclopedic Publishing, 1978.