

EXPERIMENT ON ECHO*

Emanuel Swedenborg
Translated by Erik E. Sandstrom†

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- 1 Emellan twenne wäggor 30 alnar distance gjordes ett ljud med kepp eller dylikt i andra väggen tå therwid observerades att:
 - 1 Between two walls 30 cubits [58.5 feet] apart, a tapping sound was made with a walking stick or something like that, on the opposite wall, and it was then observed that:
 - 1¹ at ljuden 4 gånger dubblade sig och ibland 5 men then femte så svag at then knapt hördes; hwarmed observerades at wid trä och emot väggar intet gjörer mehr än 4 resor genswaren kan studsa tillbaka; i thet at träet gier sig efter och dempar ljudet.
- 1 the taps resounded 4 times and sometimes five, but the fifth time was so soft that it could hardly be heard; from which one could observe that any resonance against wooden walls can not bounce back more than 4 times, because the wooden material has a “give” to it, and dampens the sound.

* The Linköping documents were photolithographed by Rudolf Tafel ca. 1869, and they included Swedenborg’s experiment titled “Om Echo,” (Regarding Echo) (1716) from which can be deduced a rough estimate of the speed of sound. The study was placed at the end of the photolithograph volume entitled *Miscellanea Physica et Mineralogica*, item number XXV, photolithographed pages 205–206 (Col. 14a, no. 154k. 1. 126) printed in Stockholm that year.

In his book *Världsmaskinen: Emanuel Swedenborgs naturfilosofi* (Bokförlaget Nya Doxa, 2004; *The World Machine: Emanuel Swedenborg’s Natural Philosophy*) pp. 179–181, author David E. Dunér translates a few snatches of Om Echo in the course of his discussion of Swedenborg’s experiment. He also kindly checked the transliteration of Swedenborg’s Swedish manuscript.

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¹ The MS has two paragraphs numbered “1”—the first acting as an introduction.

- 2 At alla 4 genljuden skedde inom $1/2$ min s: så att effter en noga utrekning, ljudet med sina 4 stds [abbr: studsar] gjorde om min:s: 400 svenska alnar, hwilcket ofta wardt observeradt och så befunnit. Hwaraf kan slutas at ljudet går om min: pr: fram och tillbakas mot 24,000 alnar eller $1/2$ mil och 6000 aln. Thet är 1 hel mil om $1 1/2$ min; pr. Tå man i proportion med watnets tyngd kan finna at thet går när thet ligger lungt och ringlar sig, at thet gör 24 aln. uti en min: pr: eller 36 aln uti $1 1/2$ min: pr: när som i vädret gör en hel mil; hwilcket ock nästan öfwerenskommer med experimentet i vatnet.

- 2 That all 4 resonances happened within one half second so that after a careful computations, the sound with its 4 bounces traveled at about 400 Swedish cubits [= 780 feet] per second, which was repeatedly observed and that is how it turned out. It could therefore be concluded that the sound goes forward and back again up to 24,000 cubits, or half a mile and 6000 cubits, per minute.² That is one whole mile in 1 and a half minutes. If you can compare that to the relative weight of water, you can find that this happens when there is a calm and rings of water circle out from the center, that it moves 24 cubits per minute, or 36 cubits per one and a half minutes, while it goes a whole mile in the atmosphere; which also almost coincides with experiments in water.

- 3 Ljudet hördes allenast ifrån andra wäggen, så hårdt som thet verkade slagit ther med samma keppenda, och skulle thet kunna deluderas en mathematicum sjelf, at wäggen tagit ett dylikt slag emot, och således om någon therewid stådt, fådt kendt samma slag; fast thet likwel intet annat är än continuation af förra ljudet, som ärnat sig fram om wäggen men genom thet och ther höres efter en tid från thet första tyckes thet höres i wäggen emot. Går man närmare then andra wäggen höres ljudet straxt ifrån then wäggen som lengst ifrån är. När man slår mitt

² 1 Aln/cubit = 23.4 inches, 59.38 cm, defined by Karl IX in 1605. 1 km/hr = 0.6213712 mph. Swedish mile in 1700s was 10689 meters, or 18000 alnar = ca. 6.6 miles. Therefore, the echo traveled 24000 alnar there and back = in 60 seconds = $8.86 \text{ m/m} \times 60 = 531 \text{ mph}$. Or 2 Swedish miles (36000 alnar, 1 mile there, 1 mile back) in 90 seconds = $13.2 \text{ miles}/90\text{s} = 8.7 \text{ m/m} = 523 \text{ mph}$. Real speed of sound is from 740 to 741.5 miles (1,191.6 to 1,193.22 kilometers), that is 331.29 metres per second at 0° C (1,086.9 feet per second at 32° F). The Academy of Sciences in Paris in 1738, measured it remarkably at 332 meters per second!

emellan, fast snarare sacht litet bättre innan medelpunkten till andra väggen än till then som slår, så höres dubble slag, eller 8; så at thet blifwer et dalrande af; ty ljudet höres från begge väggarna; men med thet förbehål at thet intet så hårdt höres, som vid väggarna.

- 3 The sound was heard only from the other wall, so forcefully that it seemed to have been made at that point with the same amount of force of the walking cane, that even a mathematician could have been misled into thinking that that wall had received a similar stroke against it, and consequently that someone had stood there, and it had received the same kind of stroke, but still it was nothing else than a continuation of the former sound, which aimed itself forward from the wall but by means of it, and it was heard after an interval from the first [sound], and it seems that it is heard from the opposite wall. If you approach closer to the opposite wall, the sound is then heard right up against the wall that is further away. If you make the stroke at a point right in between the walls, or one should rather say right before reaching the mid-point to the wall opposite from the one that echoes, then there is heard a double stroke, or 8 in total, so that there is a quivering effect; for the sound is heard from both walls, but with the qualification that it is not heard as loudly as right by the walls.

- 4 Går man emellan väggorna fram och tillbakas höres ändock ljudet men såsom thet kommer från andra punkter och ställen; men som väggen lyckades på en sida gick man från medelpunckten utåt, och knapt mot 10 steg, tå att genljudet stannad. Gick man från medelpunckten sachta utåt, hördes först thet sidsta echo stanna sedan thet andra, och så thet tredje, tå thet 4de blef nästan lika klart quar, men efter 1 slag, lyckade thet ock. Hvaraf ser at starke ljud gjöra större angulus reflexionis än mindre. Och gick man i samma angul ände ut ått 80 120 steg i lengd efter thess hypotenusas hördes alt lika, så när som långt bort. Ty kan slutas at echo för intet i oval eller ringlar från väggen uti nästan linea recta.

- 4 If you go back and forth between the walls, then the sound is still heard, but as if it comes from other points or origins; but if you

happened to go to the midpoint outward along the one wall on one side, and hardly up to 10 steps, then the resonance ceased. As you go from the midpoint slowly outwards, then at first the last echo is heard to cease, then the second, and then the third, so that the 4th one remained almost of the same level of clarity, but after 1 stroke, this too was heard the same as the others. From all this one can observe that a loud tapping makes a greater angle of reflection than the softer one. And if you went out at the same angle right up to the distance of 80 or 120 steps along their hypotenuse, then you heard exactly the same whether close up or from some distance. It can be concluded that the echo does not travel in a curved or circular motion from the wall, but almost at a right angle.

- 5 Må se på wäggens ena sida var straxt en öpning, at echo eller ljudet måste nödwändigt ända sig ther; gick man op andra sidan så lengs jemt wid weggen, tils echo intet mehr hördes; och fant at just ther yttersta angulus reflectionis var ther stannade thet; så at man knapt kan sluta, at echo diffunder sig, och går in linea recta.
- 5 One could see a small opening on one side of the wall, and that the echo or sound must necessarily collect there; if you went to the opposite side along the wall and always close to it, until the echo is no longer heard; then it was found that just where the angle of reflection was the greatest, that is where it stopped; so that one could hardly conclude anything else than that the echo dissipates itself, and travels at a right angle.
- 6 Men på andra sidan ther ingen öpning var gick man bequemt och hörde så som elljest; tils en liknande öpning eller luka fants, utaf hvilket intet mehr hördes, så at ses kan at öpning har insupit thet.
- 6 But on the opposite wall where there was no opening, you could easily go and hear all as before; until a similar opening or hatch is encountered, and nothing more is heard out of it, so that one can see that the opening has soaked it up.

- 7 Gick sjelf emellan wäggarna på åtskilliga distantia at fremst thessa och fant at thess närmare jag kom til medelpunckt thess mindre hördes thet ljudet, så at i medelpunchk intet genljud mehr var; doch ther bredewid hördes en dallring the dubbla slag, ty thet hördes snart i begge wäggarna.
- 7 I myself went between the walls at several different distances, up to those mentioned, and found that the closer I came to the midpoint, the less was the sound heard, so that at the midpoint there was no resonance at all; however, next to it was heard a quivering of double strokes, for it was heard right away in both walls.
- 8 Ther öppningen var gick jag utåt om straxt utom öppningen, ändelig motsetta echo, och hördes elljest ett enkelt echo.
- 8 When I walked outwards from that opening, just beyond the opening, right opposite the source of the echo, at that point just one single echo was heard.

Om Echo [Swedenborg's own hand, at the end of MS]

On Echo □