Summary
Mill calculations
From time to time the discussion arises among voluntary millers about which improves better a screw or a scoop wheel, with, as an outcome, that the screw is preferred. Already from 1640, the Archimedian screw drainage mill has been applied in the Netherlands. The expectations frequently didn’t work out or were too small. Also measurements are not simple to determine improvements. Here follows a number of practical examples.
Simon Stevin (1548-1620) was one of the first with proposals for improving the scoop wheel. In 1589 he was granted nine patents. Already in 1486 at Haastrecht several mills were operating in serial for the drainage of the polders. As a result of the drainage of the polders, the soil shrank further resulting in an increasing height difference between polder and basin. By improving the sails the mill turns more rapidly. The scoop wheel shaft turns in general two times slower than the wind shaft. Normally the upright shaft turns more rapidly than the wind shaft and a large delay is used for the scoop wheel shaft.
Simon Stevin introduced a smaller wheel beside the brake wheel for traction of the centre post resulting in a lower but more powerful speed of the scoop wheel. By constructing a double width scoop wheel the draining capacity was improved. The large brake wheel then only acted as a brake. A disadvantage of this improvement was that the forces on the cogs also became larger and wear appeared more rapidly.
The English engineer John Smeaton published *On the construction and effects of windmill sails* and proved that the capacity of wind mills was almost proportional with the square of the sail cross and with the third power of the wind speed.
The Dutch appeared to have the best results of the examined sail forms. The invention of Ferdinand Opdam was to provide an ordinary mill with three enclosed Archimedean screws. Depending on wind speed one could attach one, two or three screws into gear to adjust the capacity. The main question was how heavily a mill should rotate?
With a wider scoop wheel or a screw with a large diameter one can intensify the water flow capacity enormously but if there are only two days per year with sufficient strong wind power it does not make much sense.
In 1760, the capacity of two mills were compared by the foreman and land-surveyors of the Hoogheemraadschap of Rijnland, Jan Noppen, Melchior Bolstra and Dirk Klinkenberg. It appears that the screw mill gives less water than the scoop mill, as mentioned in the proportion 7 to 5, but because the water raising level of the screw is larger, the capacity of the screw mill nevertheless becomes larger. The land-surveyors reach the conclusion that the seven mills of Opdam do just as much as ten ordinary scoop wheel mills. For the comparison of mills the method of Stevin was frequently followed by multiplying the flow with the raising water level.
Also it is known that a scoop wheel can grind 'against' which means that the water outlet can lie partially under the basin level which limits the level of raising water.
Anthoine George Eckhardt invented the mill with tending scoop wheel in 1771, and claimed that twice as much water could be pumped compared with vertical scoop wheels. In the Bleiswijkse land reclamation it becomes clear from tests between the inclined scoop wheel and the vertical scoop wheel that the inclined scoop wheel performs a little better but certainly not twice as well! However at higher water level in the polder the performance of the vertical scoop wheel proves better then the inclined scoop wheel.
Based on earlier tests, Eckhardt thought that his inclined scoop wheel would improve much better, but we see here that if the circumstances are exactly the same, such as the level of raising water, sails and wind, the differences melt away. The same also appears to apply to the comparison of the scoop wheel and the screw.
Principle of Stevin for discussion.
The principle of Stevin, that the capacity of a mill is determined by the product of flow and the water level differences not exactly correct because the energy losses are not taken into account. For a mill with larger raising water levels these losses are relatively smaller than for mills with lower

raising water levels. Because of this the Archimedian screw mill becomes favorably in many tests. Because the size of a scoop wheel is related to the raising water level we find that these scoop wheels at larger raising water levels do not fit so easily inside the mill because of the increased diameter. It also becomes more difficult to achieve the desired gearing because larger scoop wheels must turn slower. We have to operate with a smaller capacity at large raising water levels. Because of the limitation of the capacity of the traditional wind mill, larger scoop wheels should be lesser in width and therefore will become too slack. So the scoop wheel only performs well in the largest mills with raising water levels of up to 2 meters. The screw is in this case more flexible because one can give less water to the screw at increasing water raising levels. Also a screw can turn much more rapidly than a scoop wheel, so that correct gearing seldom gives problems. At small mills with relatively large raising water levels replacing the scoop wheel with a screw gives more advantage. But the scoop wheel mill in the Bovenkerkerpolder showed that the right choice depends on local circumstances. For example, however, this has been done in the Schermer This can only have helped , if the scoop wheels there were not optimally designed.

Morality of this article:

1. At rather fixed levels and raising water levels of around a meter and a desired capacity of 30 to 60 m3/min, this can be obtained with one mill which can be equipped with a screw, vertical scoop wheel, inclined scoop wheel or scoop disk. If designed well it will not make any difference which construction is used.
2. There are circumstances (such as changing basin level) where the scoop wheel has the preference above the screw.
3. As the raising water level becomes larger, its relative loss will become smaller and the efficiency of every water draining machine larger. It is therefore favorable at high water raising levels to use as few mills as possible in serial.

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