

## Archimedes Screw! Say Who?

Colvin Run Mill park is rightly proud of the mill's automation, the highest technology of 18<sup>th</sup> century America. Using simple machines that change the direction or magnitude of a force, inventor Oliver Evans was able to reduce the amount of human power to operate the grist mill by half. You remember the six simple machines, right? If not, ask the third graders who are learning, hands-on, the wonder of these "simple" machines at the park. (Answers at the end for those who might need refreshing.)

When giving tours of the mill we explain that freshly ground flour is pushed through closed wooden troughs by an Archimedes screw. The usual reaction from visitors is total silence. I am either impressed that the term needs no explanation, or depressed that folks don't want to admit they don't know or don't really care to know about this ingenious simple machine. It helps that we have a model that shows the screw in action, pushing little yellow beads into small cups. Heads nod.



I am still waiting for: "Archimedes screw? Say who?" "This doesn't look anything like the screw I used to fasten hinges on the screen door!" To prepare myself for that eventuality – which may never come – I did a bit of research.

Archimedes was a Greek mathematician, physicist, engineer, astronomer and inventor who lived from 287 to 212 BC in Syracuse in what is now Sicily. He invented war machines to defend the city against the Roman Republic, but to no avail. The city fell, and Archimedes was killed. The practical Romans were not as curious to solve abstract math problems as the Greeks. One historian summed it up: "In the year 1500 Europe knew less than [when] Archimedes ...died."

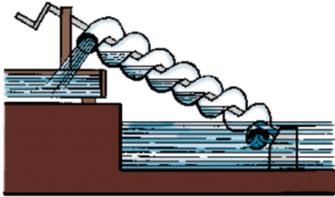
Archimedes derived and proved a range of geometrical theorems, like the area of a circle and the volume of a sphere. He set the stage for calculus, invented a pulley system to help sailors unload cargo, and famously said "Give me a lever long enough and a fulcrum on which to place it, and I shall move the world." The superman of simple machines.

Ever hear someone exclaim: "Eureka!" which is Greek for, "I have it!" "I have solved the problem!?" Archimedes is the guy who made the word famous. Tasked by the suspicious King Hieron to prove that his new crown was not pure gold, talented Archimedes sought a solution, but without success. Frustrated, he decided to go soak in the bathtub.

As he settled in, the water in the tub rose and spilled out. He surmised that the weight of the water he displaced was equal to his body's weight. Thrilled that he had finally cracked the nut, he jumped out of the tub and ran through the streets shouting "Eureka!" One thing: he forgot to dress. A bit of a spectacle. And another thing: the crown was not pure gold, the weight of the

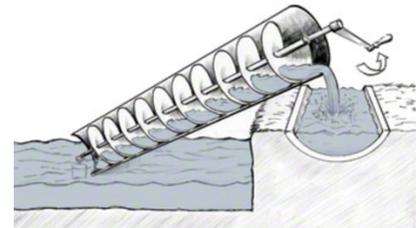
water the crown displaced was less than the weight of gold. The story broadly conveys what became known as Archimedes' principle, fundamental to fluid mechanics.

What about his screw? Turns out Archimedes didn't invent it but saw it in operation in Egypt. The locals lifted water from the Nile River to their irrigation ditches by rotating a shaft with a tube wound in an ascending spiral around it – which if you think about it, is really a circular inclined plane. River water would enter the tube, and, with each turn of the shaft, rise in the spiraled tube and pour out the other end.



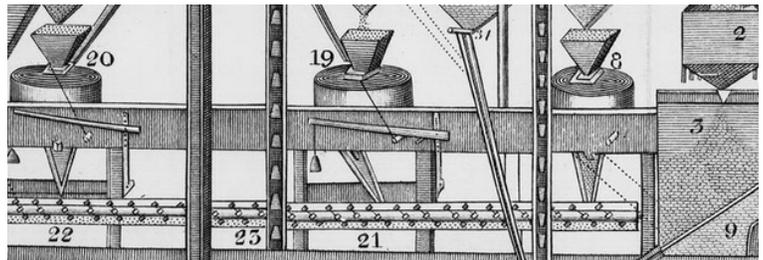
In further refinements, the twisted curve of tubing was substituted by larger inclined planes - "threads," – rotated inside a large cylinder. Hence, the screw: a simple machine

that converts rotational motion to linear motion and torque (rotational forces) to linear force.



Archimedes screws are used to move bulky materials because they can turn at different flow rates and are considered "gentle" since the threads lift as they turn rather than push. They are used to delicately move grapes into the wine press, comfortably lift live fish from one pond to another( a "pescalator!"), unceremoniously drain nasty sewage containers, and, in a completely different set up, softly percolate tasty hot liquid chocolate in fountains!

Oliver Evans adapted an Archimedes screw to move grain and flour horizontally and called it a "conveyer," an eight-sided shaft, with small inclining boards, called "flights," for "conveying the meal from one end of the trough to the other."(see 21-22 in picture)



Such horizontal screws are used in farm combines to pull plants, like wheat, from the ground and feed it into a processor.

Eureka! Archimedes and his screw! Now I am ready. Go ahead and ask: "Archimedes screw? Say who?"

For the record: the screws used to fasten hinges to a door were not invented until the 15<sup>th</sup> century when screw cutting lathes were invented to fashion tiny threads.

Answer: The six simple machines are: lever, wheel and axle, pulley, inclined plane, wedge, and screw.