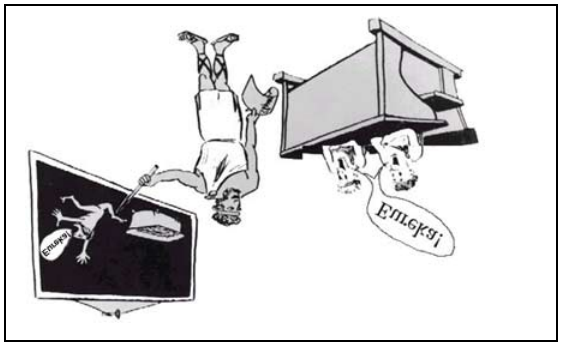


Dr. Abram TEPLITSKIY

STUDENT'S CORNER #11 WHEEL AND DIVERSE PROBLEMS IT COULD SOLVE

The wheel is one of the most important inventions of all times. Practically every machine, especially moving, involves such single, basic part, which became one of mankind's principal inventions. We already discussed in our Student's Corner few simple yet effective devices like Lever and Funnel, and we'll discuss more simple machines, because they could be named an Alphabet of Technology. As for writing and reading we need to know alphabet, which contains letters, for making machines and operate them we need "machine alphabet," which contains simple machines and unique elements!

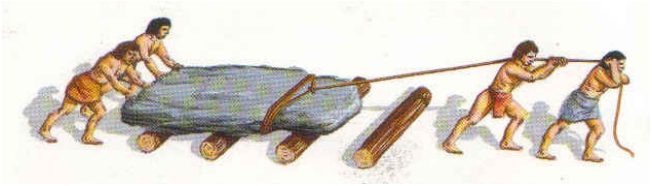
Let's start our journey to Country of Wheels from discussing a question – how wheels appeared in our life. Most archeological books explained that wheel is, probably, one simple machine, which wasn't copied from nature. For example, origin of the bridge specialists connected with a case when a tree heated by a lightning failed across a stream, and ancient people got an opportunity to go across the stream using such first bridge. Next time same people for solving such "traveling" problem cut a tree, which failed and become an artificial bridge. We want to share with members of our Student's Corner with some reasons for "sharing" idea of a bridge with Nature. Let's consider Sun – it rotating around the Earth – couldn't such rotation bring an idea of a wheel? Or look over a picture of a sunflower below – isn't it looks like a rotating wheel, which rotates slowly, following the motion of Sun?

Courtesy of Motiar Ruhman

Also can you imagine for a moment that all the "Sunflower Forest" would start to rotate their heads? Now if somebody would get an idea to connect such "sunflower wheel" to generator, it would produce a lot of electricity, what do you think? In real life one such proposal came to one children newspaper in Ukraine – readers proposed such sunflower "power" station!

Courtesy of Motiar Ruhman

Now let's consider a stump of a tree. Its part without brunches potentially can rotate, and after seeing such occasional rotating, could our ancestors get an idea of a wheel? We would be happy to get any opinions from our members on this question.



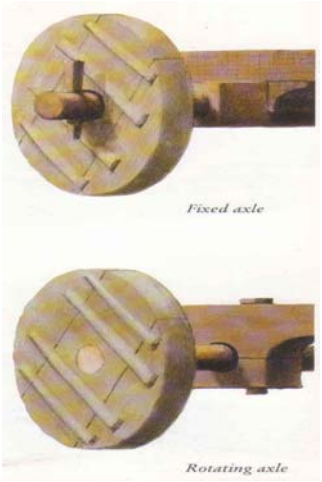
Courtesy of Igor Endovtsev

What do you think, could above schematic pictures bring to people an idea of railroad transportation? Or such idea came from caterpillar?

Courtesy of Free Internet Wikipedia encyclopedia

Based on diagrams on ancient clay tablets, the earliest known use of this essential invention was a potter's wheel that was used at Ur in Mesopotamia (part of modern day Iraq} as early as 3500 BC. The first use of the wheel for transportation was probably on Mesopotamian chariots in 3200 BC.

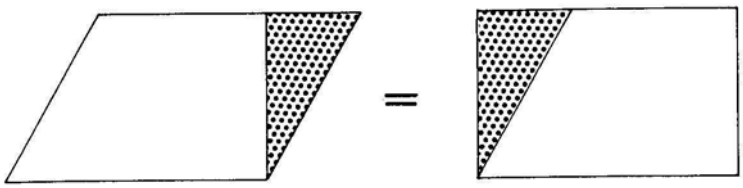
Wheels for transportation means were developed in two major options, depending of how axle interact with wheel – with fixed axle and with rotating axle. Both options are shown in the picture to the right.



If we completely blot out the principle of rotation, all power-driven transportation would disappear. There wouldn't be any water wheels, windmills, steam engines, automobiles, trains, airplanes, and much more different stuff. There wouldn't be even hoarse-drawn carts or wagons. In its almost infinite variations of the wheel as an integral part of almost any modern technique from clock to the automobile, from the smallest turbine to the biggest machine tool. Our modern civilization runs on wheel!

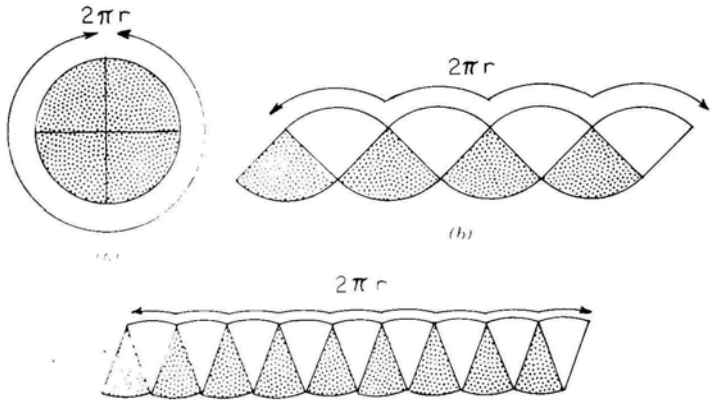
It is interesting to note that wheels may have had industrial or manufacturing applications before they were used on vehicles. A wheel with spokes first appeared on Egyptian chariots around 2000 BC, and wheels seem to have developed in Europe by 1400 BC without any influence from the Middle East. Because the idea of the wheel appears so simple, it's easy to assume that the wheel would have simply "happened" in every culture when it reached a particular level of sophistication. However, this is not the case. The great Inca, Aztec and Maya civilizations reached an extremely high level of development, yet they never used the wheel. In fact, there is no evidence that the use of the wheel existed among native people anywhere in the Western Hemisphere until well after contact with Europeans. Even in Europe, the wheel evolved little until the beginning of the nineteenth century. However, with the coming of the Industrial Revolution the wheel became the central component of technology, and came to be used in thousands of ways in countless different mechanisms. Before we'll investigate the endless world of wheels, let's consider one problem, closely connected with one of the wheels parameter - how diameter of the wheel is connected with its area. We are sure that MEMBERS OF OUR Student's Corner knows from math about Pi number, which is a factor in equation between circumference of a wheel and its diameter, and they also know the value of this factor – 3,14.

We were happy when we found one simple way how ancient "math scientists" found this value. First, consider more simple method of calculating of parallelogram area, which is illustrated by following picture. We can give to this method a title – substitution method. What it takes, really is to cut right triangle from left parallelogram and attach it to the left part of the right parallelogram, and as result this second parallelogram would become a rectangle, and determination of the rectangle area is really easy for our readers.



Courtesy of Wikipedia Internet Encyclopedia

Now try to apply same procedure to area of a circle, and you'll see that is not so easy trick. But it is possible to do for everybody. And approach could be used is same as for parallelogram. Observe following picture, analyze proposed substitution of sectors, and try it.



Courtesy of Wikipedia Internet Encyclopedia

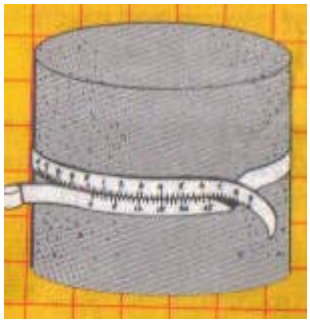
Above we got some knowledge, which connects the circumference of wheel with its diameter. Now think how we can use this knowledge in everyday human practice. If your first thought would be about measuring length of some elongated "staff", you are right – Engineers for a long time are already measuring linear sizes on roads, construction sites, and other such objects so-called Engineering Wheel, shown in the following pictures. In the picture in the middle you can see measuring wheel with rotations counting device. If you know the circumference of wheel and counting amount of its rotations, you can calculate the length of wheel's path. In the pictures below there are shown process of measurement on the asphalt covering and on the

grass surface. It is an evidence how knowledge got practical use, and also how math brings real practical feedback to people.



Courtesy of Igor Endovtsev

But PI number helps not only when wheel is a measuring tool. Another option – when you need to measure diameter of a cylinder as necessary in everyday practice of Construction materials testing Laboratories. If you would use a compass, you'll need to do few measurements to find out an average value of a diameter. Now look over a picture below.

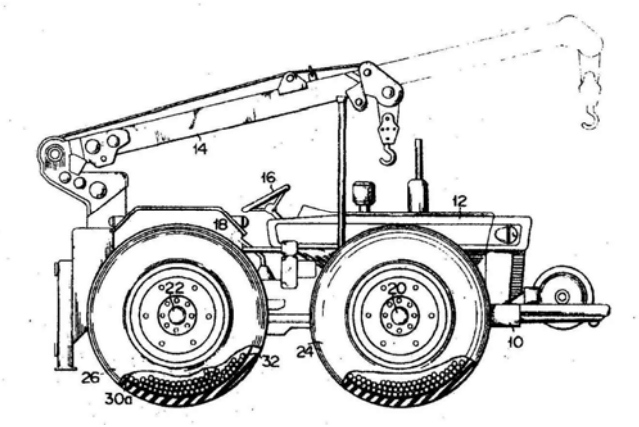


Courtesy of GEE Consultants, Inc.

You can see that a tape around the cylinder is exactly a wheel! So we can apply our knowledge about PI, and calculate the diameter! To make this process more comfortable, the tape along its length has numbered in linear units. Matching numbers on both parts of this tape shows the diameter of a cylinder under testing.

Now we'll share with members of Student's Corner with structure of structures of wheels, which we found among patents databases of USA, Russian Federation, and other Countries. We'll start from invention, in which small metal balls increased stability of a tractor motion. It is not a secret that wheels for some tractor models

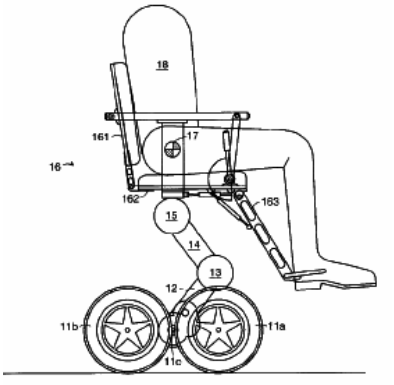
have big diameter to provide better access to area of service. But when access becoming better, the stability becoming worse because the center of gravity of tractor becoming higher. One Japanese inventor proposed an original structure of tractor wheel, which is shown in the following picture.



Public Domain – US Patent #3,176,093

A wheel for rolling stock such a tractor which comprises a wheel rim caring a pneumatic tire having an annular tire cavity and a plurality of substantially spherical balls having a relatively high density, a packed layer of the ball partly filling the tire cavity. When the axis of the wheel is positioned horizontally, the wheel can have a gravity center at a lower point than the axis thereof due to the presence of the heavy balls positioned at the bottom portion of the tire cavity. It is a smart solution, and readers can save it for future invention practice.

One of the most famous wheels, invented recently, was "moving" wheel, invented by Dean Kamen, scheme of which is shown in picture below. It is a two-wheeled bike (scooter), which is equipped with computer, set of sensors and gyroscopes. Mr. Dean Kamen considered that his scooter would be next step in evolution after automobile, as automobile became a next step after horse with a cart.



Public Domain – US Patent #5,975,225

The support and the ground-contacting module are components of an assembly. A motorized drive, mounted to the assembly and coupled to the ground-contacting module, causes locomotion of the assembly and the payload over the surface. A CG modifying arrangement is provided for actively modifying the location of the center of gravity of the assembly. Finally, the embodiment has a CG control loop, in which the CG modifying arrangement is included, for dynamically enhancing stability of the vehicle by operation of the CG modifying means based on at least one of motion or orientation of the vehicle. Some options of usage such computerized "machines" are following. Author saw few times usage of such computerized machine – once driving by a policeman (Rice University, Houston), another time around one of Elementary schools in Dallas while students were on break. The right picture shows an inventor of this scooter while explaining its features.



Courtesy of Wikipedia Free Internet Encyclopedia

As next example of such originality, we propose readers observe a unique Rolling Bridge, which was created and built in London, and illustrated by following pictures.



Rolling Bridge in London.

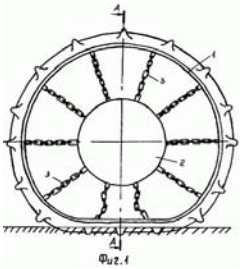
Courtesy of Free Internet Wikipedia Encyclopedia

Now we'll learn more of how different types of wheel work. Let's start from bicycle wheels. Initially they were made from wood, than came time for metal wheel, but all these types were very rigid, and rider's body felt any road roughness. Time was passing by, and at the end of 19 century a veterinarian Dunlop from Scotland got an idea to put on bicycle wheels rubber tires. The idea came to Dunlop when he was watering his garden using a rubber garden hose, as shown in the following picture.

Such tires for bicycle are still in use. Since this time tires became necessary parts of wheels. Moreover, later on tires was advanced, and it even started a line a self-sealing tires like one described in US patent # 4,206,796 – Tire with self-sealing Inner Coating.

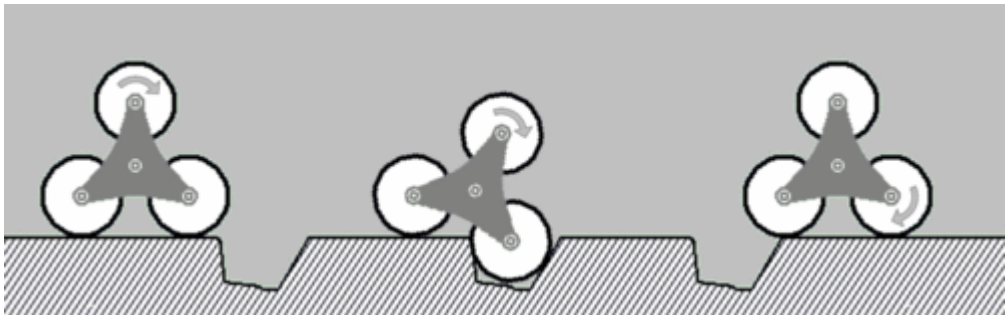
Courtesy of Anatoliy Kobelnuk

Can you imagine bicycle, which has flexible rim, connected with the center of wheel by sections of chains. Rim is made with twisted inside edges on the ends of section and has a tire with crimp seal, which are twisted in opposite direction, which are interacted with crimp seals of rim. Inside the tire a transmitting link is placed. Rim is made from elastically deformed polymer material, and tire-cover is made from rubber. From inside the rim, at its center a circular lug, through holes in it are passed the elements of chains connections< each pair of which is connected with the ends of center of wheel, forming triangle-like structures. Chains are connected with centers of a wheel with providing ability of its tension, for example by using a common tightening screw for two chains. As result described system provides smooth work, without making any noise, works with higher speed, and lower pressure on the soil while operating. One more spectacular wheel with flexible rim is shown below in following picture.



Public Domain – RU Patent RU Patent # 2279986

Now let's return to unique structures of wheels, one of which is shown below – it so-called Tri-Star version of a wheel.



Scheme of Tri-Star Wheel

Courtesy of Free Internet Wikipedia Encyclopedia

The tri-star is a novel wheel design—originated by Lockheed in 1967—three wheels are arranged in an upright triangle with two on the ground and one above them. If either of the wheels in contact with the ground gets stuck, the whole system rotates over the obstruction.

Now we'll introduce to Student's Corner Members Water and Wind wheels, which started their life when the Industrial Revolution came. In pictures below you can see one of the initial types of water wheels, which could work under forces of falling or moving water, for example under action of waterfall, a dam, or any other natural source of moving or falling of water. Later people started to construct artificially dams with big height level of water. Energy of falling water is the source of energy to rotate the turbines of generators to produce electricity, and also to rotate axles of different machines to produce motion in all diverse industry branches. In the picture below readers could see examples of water wheels.

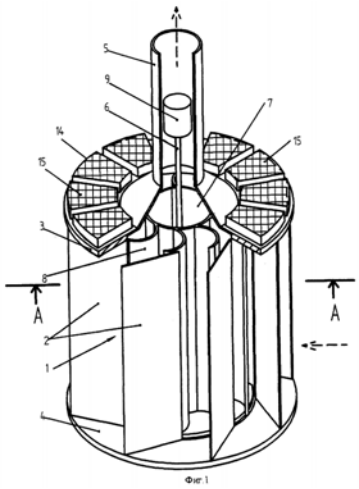
Water – Wheel-1

Water – Wheel-2

Waterfall

Courtesy of Free Internet Wikipedia Encyclopedia

Let's notice that water wheel could easily work under waterfall – what it needs, it is vertical falloff water on its blades. Under energy of falling water wheel would rotate energizing a generator or any machine. Another 'free" option to rotate wheel is also chip – energy of wind. Because of its principle, of wind wheel can work under any direction of wind, not like water wheel, which work mostly under vertical falling water, but under any direction of wind. One of possible structures of wind wheel is shown in picture below.



Public Domain – RU Patent #2251022

Later on appeared another type of wheels – observation wheels, which was used for pleasure of inhabitants of big cities and their gests. One of such wheels, erected in London, is shown in following picture.

Millennium Wheel (London)
Courtesy of Free Internet Wikipedia Encyclopedia

Now we'll tell you about a very important part of any wheel – ball bearings. A ball bearing is a common type of rolling-element bearing, a kind of bearing. The term ball bearing sometimes means a bearing assembly which uses spherical bearings as the rolling elements. It also means an individual ball for a bearing assembly. The remainder of this entry uses the term ball for the individual component and ball bearing or just "bearing" for the assembly.

Courtesy of Wikipedia Free Internet Encyclopedia

Ball bearings typically support both axial and radial loads and can tolerate some misalignment of the inner and outer races. Also, balls are relatively easy to make cheaply compared to other kinds of rolling elements. Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings.

We'll share with our Members with a problem. All balls for bearings need to be tested to guaranty safety of all moving parts all over the world. How to test such huge amount of different balls, which have very different sizes by cheap and effective way? We'll be happy to analyze your proposals, and tell you what other people in the world had proposed to solve this problem.

Student's Corner # 11 was prepared by group of Enthusiasts under leadership of Dr. Abram Teplitskiy and First lady of Lucas, Texas Jennifer Sanders.

Happy Inventing!