Geek out with BART on Pi Day, March 14, 2015

Have you ever thought about pi on BART? Not the lemon meringue or deep-dish apple kind – the mathematical one. Turns out pi is used in lots of ways at BART. Pi is a mathematical constant, the ratio of the circumference of a circle to its diameter. It's typically written as 3.14159 and is celebrated with Pi Day on March 14. This year is being called a "once in a lifetime" Pi Day. If you extend the digits out to the hour, minute and second, you get 3.14.15 (March 14, 2015) at 9:26:53 (just before 9:30 in the morning and evening). If you happen to be on a BART train at that time, give a cheer for pi!

FIVE WAYS PI IS USED AT BART:

1 piNTS OF PAINT

CALCULATION OF SQUARE FOOTAGE FOR PAINTING CONTRACTS

We had to use pi to calculate the square footage of the Hayward, Concord, and Richmond yard concrete car turntables for cost estimating the re-surfacing and painting contracts. If the outer concrete pad edge radius is 31', and the inner concrete pad edge radius is 19.5", Concrete area is pi x (31) squared - pi x (19.5) squared = 1825 square feet of concrete to re-coat and re-paint. This can save money because it lets the contractors making the bids know exactly how much is needed of paints that are sometimes very expensive – an imprecise estimate could result in costly changes.

2 piECES OF CABLE

CABLE SAVINGS

In Communications Maintenance, we often come upon a project where we need a certain length of cable. In our storage areas, we usually will have coils of cable that were left over from previous projects. So in order to make good use of these coils of perfectly usable cable and to avoid ordering a new spool, we will use pi to calculate the approximate length of the coiled cable using the following formula:

(number of loops in the coil) x (diameter of the coils) x (pi)

This has been a proven technique and saves time, money and the environment.

3 piPES FOR WATER

MEASUREMENT OF WATER FLOW VELOCITY THROUGH PIPES

If we have large fire main piping with a 12 inch inside diameter, we know that the inside area is pi x (0.5')squared = 0.7854 square ft. If we want to keep average water flow velocity through the pipe no greater than 15 feet per second, we know that the pipe can deliver no more than 0.7854 x 15 = 11.78 cubic feet of water per second, or about 5300 gallons per minute. That's an important calculation for safety, to make sure water could be pumped at the correct level should the need arise.

4 A SpiN ON WHEELS

TRAIN CAR MAINTENANCE

Routinely, the diameter of BART car wheels are measured and recorded using a "pi tape" (a standard railroad measurement tool) which wraps around the circumference of the wheel, but directly gives a readout of the wheel's diameter. Those diameter measurements are entered into each vehicle's computer where they are used for the physics motion equations. Note that the wheels on BART cars start off with 30 inch diameters, and are replaced when they get down to 28 inches.

For every revolution of a wheel, the car will have traveled one wheel circumference, which is pi x diameter. With this calculation, the control logic can determine and record distance. On the average, BART's fleet of cars run around 115,000 miles per year, which is about 80 million axle and wheel revolutions. (Students can be challenged to do the math on this one, using an average fleet wheel diameter of 29 inches, and the 115,000 miles figure. The calculation involves pi.)

Speed is calculated as distance divided by time, so the control logics can determine, control, and record traveling speed. BART cars are designed to operate up to 80 mph. (Students can be challenged to calculate what the axle speed would be, in revolutions per minute, if the car has 28 inch wheels and is traveling at 80 mph. Again, pi has to be used in the calculation. Answer: 960)

5 SHApiNG CURBS

VEHICLE AND PEDESTRIAN SAFETY AT BART STATIONS

In order to maximize the transit options at our Station Sites, BART has to accommodate bicycles, buses, pedestrians, and personal vehicles in somewhat tight spaces. While designing these spaces, we use pi to measure angles and radiuses of the street and curbs where they turn to be sure there is sufficient space. If we know the maximum turning radius of a bus is 45 feet while making a right turn, then using pi we can determine that the radius of the curb/sidewalk measured from the same point must be 25 feet or less. This allows for enough space to accommodate all of the different transportation modes without forcing a turning bus into a bike lane or onto a sidewalk.