

Teaching Math Using a Pulley

By Scott Little

My main job description is Contractor, Systems Engineer and Project Manager for my family business, a material handling systems integrator. In addition, I teach and tutor math and science on a part time basis. On Tuesday May 1st 2007, I participated in teaching an Algebra I class at Rialto High School in Southern California. The program coordinator is the Alliance for Education, which is affiliated with the San Bernardino County School District.

What they do is invite local professionals to come and teach math and science courses using what they do in their jobs. They have more than 1,200 partners throughout the county and have held classes in areas as diverse as Forensic Science and fire fighting. These classes are held within the time frame of a regular school day and may involve a field trip. In my case, it was held in the math class of Mr. Yuri Gonzalez.

In March I met with Alliance members Mr. Kevin Baker, Business/Community Liaison, and Mr. Kim Terry, Math Curriculum Specialist. We discussed what math problem to use for the class, one that would be at the students' skills level. We agreed that an Algebra problem involving changing speeds on a conveyor system by changing the diameter of the drive pulley would be a good example.

The nuts and bolts of the problem are:

the revolutions per minute (RPM) of the drive motor X (the diameter of the pulley X
 π (3.14)/ 12) (to convert from inches to feet) = feet/minute.

$$\mathbf{RPM \times (d\pi/12) = FPM}$$

As can be seen, by increasing the diameter of the pulley, you can increase the speed of the conveyor, if all else remains constant.

The steps the class used in solving the problem are shown below:

1. Plug in numbers. RPM=30, FPM=30. : **$30 \times (d\pi/12) = 30$**
2. Then multiply both sides by 12: **$30(d\pi) = 360$**
3. Divide both sides by 30: **$(d\pi) = 12$**
4. Divide both sides by π : **$d = 12/\pi = 3.82$**
5. The answer is **$d = 3.82$**

Mr. Terry set aside the task of creating the PowerPoint presentation on the problem, and I began to brainstorm with him on creating a suitable demonstration. We decided that a portable conveyor would be best, one in which the speed could be changed.

I brought a section of roller shelving home from work to begin building. I ended up taking a motor out of an old fan that I bought at a garage sale. The motor had a variable speed drive on it, which I needed. I attached a rubber band to the shaft coming out of the motor, and then wrapped it around one of the rollers.

I then attached another series of rubber bands around each consecutive roller, so that each one wrapped around the next roller after it. When I turned the fan motor on, it turned the roller it was attached to, which in turn turned the next 3 rollers they were attached to, and so on. Please see the conveyor drawing below.

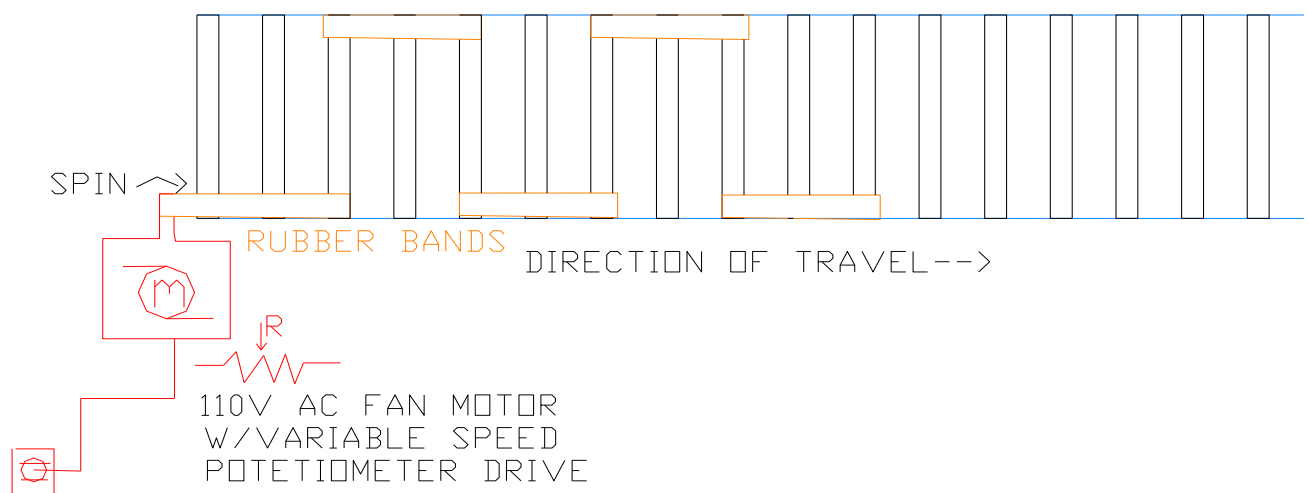


Fig.1 conveyor drawing. Drawing courtesy of Scott Little

Here I am teaching the class and introducing the math problem:



Photo courtesy of Alliance for Education

After I had gone through the presentation, I invited some students to come and try the sample problem using different values. Here is one student that answered the call:



Photo courtesy of Alliance for Education

After I had shown the presentation, I demonstrated the principle of changing the speed by changing the pulley size. Instead of changing a pulley on the conveyor which would have been time-consuming, I adjusted the variable speed drive to change speeds.

Here are a couple of photos of myself and some students running the conveyor using a VCR tape as cargo.

I would have them hold the conveyor and put the tape on it, then I would adjust the fan drive to slow it down.



Photos courtesy of Alliance for Education

I enjoyed teaching this class and hope to do many more in the future. The PowerPoint slides used in the class presentation are attached here. For more information on the Alliance for Education, you can go to their website. www.sbcalliance.org

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Scott Little, Systems Engineer

May 1, 2007

Rialto High School Algebra I Classes

Introduction

- Background
 - Personal Background
 - Company Background
- Interesting Facts

Math in the Field

- Speeds
- Horsepower
- Ohm's Law
- Trigonometry
- And much more...

Vocabulary

- Conveyor belt
- Pulley
- Diameter
- RPM
- Feet-per-minute

Feet-per-minute Formula

$R = \text{RPM}$

$d = \text{Diameter of pulley}$

$F = \text{Feet-per-minute}$

$$R \left(\frac{d\pi}{12} \right) = F$$

Example

A specific conveyor belt application requires that the conveyor belt deliver at 60 feet per minute. If the RPM of the driving pulley is 32, what diameter pulley do we need to use?

Use:

$$\text{RPM} = R$$

$$\text{Diameter of pulley} = d$$

$$\text{Feet-per-minute} = F$$

$$R \left(\frac{d\pi}{12} \right) = F$$

$$32 \text{ rpm} \left(\frac{d\pi}{12} \right) = 60 \text{ ft/min}$$

$$32 \left(\frac{d\pi}{12} \right) = 60$$

$$\frac{32d\pi}{12} = 60$$

$$\cancel{(12)} \frac{32d\pi}{\cancel{12}} = 60(12)$$

$$32d\pi = 720$$

$$\cancel{32}d\pi = \frac{720}{\cancel{32}}$$

$$d\pi = 22.5$$

$$\cancel{d\pi} = \frac{22.5}{\cancel{\pi}}$$

$$d \approx 7.162$$

Answer: We need to use a pulley with a 7.162 inch diameter.

Guided Practice

A specific conveyor belt application requires that the conveyor belt deliver at 90 feet per minute. If the RPM of the driving pulley is 36, what diameter pulley do we need to use?

Use:

RPM=R

Diameter of pulley= d

Feet per Minute= F

$$R \left(\frac{d\pi}{12} \right) = F$$

$$36 \text{ rpm} \left(\frac{d\pi}{12} \right) = 90 \text{ ft/min}$$

$$36 \left(\frac{d\pi}{12} \right) = 90$$

$$\frac{36d\pi}{12} = 90$$

$$3d\pi = 90$$

~~$$\frac{3d\pi}{3} = \frac{90}{3}$$~~

$$d\pi = 30$$

~~$$\frac{d\pi}{\pi} = \frac{30}{\pi}$$~~

$$d \approx 9.549$$

Answer: We need to use a pulley with a 9.549 inch diameter.

Independent Practice

A specific conveyor belt application requires that the conveyor belt deliver at 30 feet per minute. If the RPM of the driving pulley is 30, what diameter pulley do we need to use?

Use:

$$\text{RPM} = R$$

$$\text{Diameter of pulley} = d$$

$$\text{Feet per Minute} = F$$

$$R \left(\frac{d\pi}{12} \right) = F$$

$$30 \text{ rpm} \left(\frac{d\pi}{12} \right) = 30 \text{ ft/min}$$

$$30 \left(\frac{d\pi}{12} \right) = 30$$

$$\frac{30d\pi}{12} = 30$$

$$\cancel{(12)} \frac{30d\pi}{12} = 30(12)$$

$$30d\pi = 360$$

$$\cancel{30} \frac{d\pi}{30} = \frac{360}{30}$$

$$d\pi = 12$$

$$\cancel{d\pi} \frac{d\pi}{\pi} = \frac{12}{\pi}$$

$$d \approx 3.82$$

Answer: We need to use a pulley with a 3.82 inch diameter.

Hands-on

- Conveyor Belt Model

Thank You

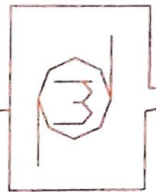
- Questions?
- Final thoughts
- Comments



SPIN →

RUBBER BANDS

DIRECTION OF TRAVEL-->



110V AC FAN MOTOR
W/VARIABLE SPEED
POTENTIOMETER DRIVE

