Marked by Teachers
This document was downloaded from www.markedbyteachers.com

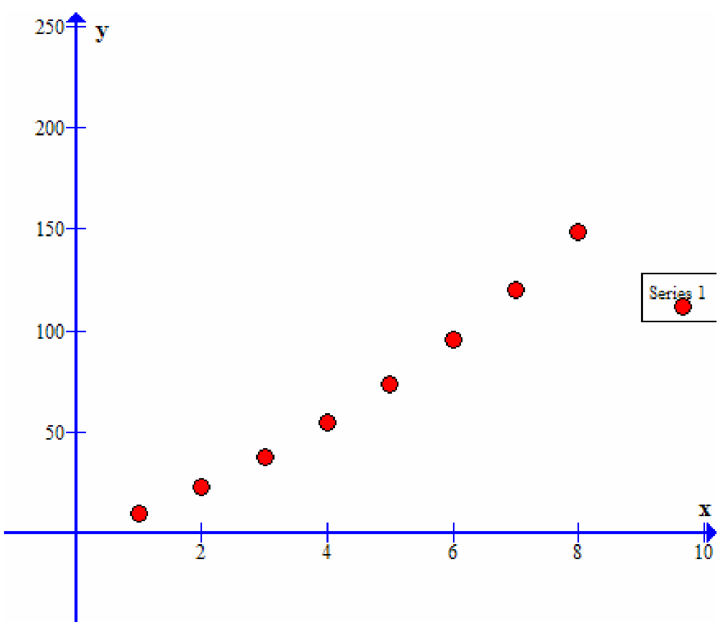
Ismar Hota

Math Portfolio: Fishing Rod

The table shown below shows the distance for each of the line guides from the tip of the fishing rod.

x	Guide number (from tip)	1	2	3	4	5	6	7	8
y	Distance from tip (cm)	10	23	38	55	74	96	120	149

The information in the above table can be presented on a XY graph; where guide number is shown on X axis and the distance from the tip is shown on the Y axis. (See graph below)



From this graph one can come to a conclusion that the points represent a part of a quadratic function. A matrix method ($AX = Y$) will be used to define parameters of the quadratic function ($ax^2 + bx + c$) using a given points (table above).

The matrix method:

Points: (1,10); (2,23); (3,38)

$a + b + c = 10$
$4a + 2b + c = 23$
$9a + 3b + c = 38$

Marked by Teachers
This document was downloaded from www.markedbyteachers.com

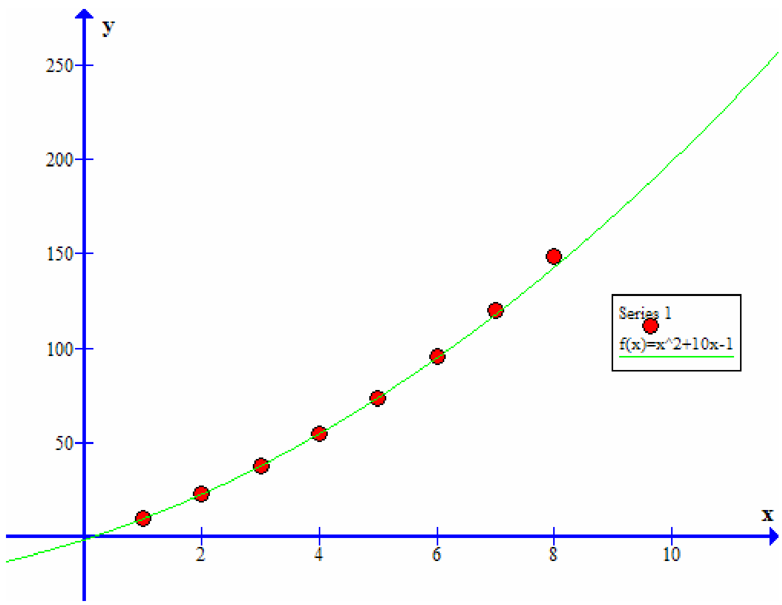
$$\begin{pmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 10 \\ 23 \\ 38 \end{pmatrix} \Rightarrow \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 1 & 1 & 1 \\ 4 & 2 & 1 \\ 9 & 3 & 1 \end{pmatrix}^{-1} \begin{pmatrix} 10 \\ 23 \\ 38 \end{pmatrix} = \begin{pmatrix} 1 \\ 10 \\ -1 \end{pmatrix}$$

From matrix result it follows:

a = 1
b = 10
c = -1

When plugged back to the $ax^2 + bx + c$, the result is quadratic function

$$y = x^2 + 10x - 1$$

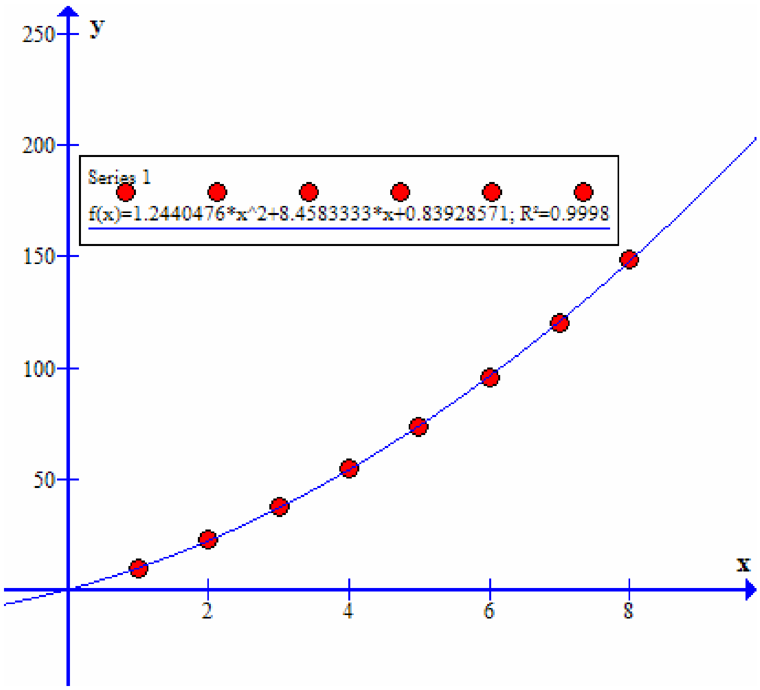


From the graph it is visible that the first five points fits the quadratic function exactly however afterwards the points don't correspond the curve. This could be proved by calculating points from the function (see table below)

x	Guide number (from tip)	1	2	3	4	5	6	7	8
y	Distance from tip (cm)	10	23	38	55	74	96	120	149
$y = x^2 + 10x - 1$	Distance from tip (cm)	10	23	38	55	74	95	118	143

Marked by Teachers
This document was downloaded from www.markedbyteachers.com

Using graphing software the lack of correspondence to the curve can be narrowed (see graph below).

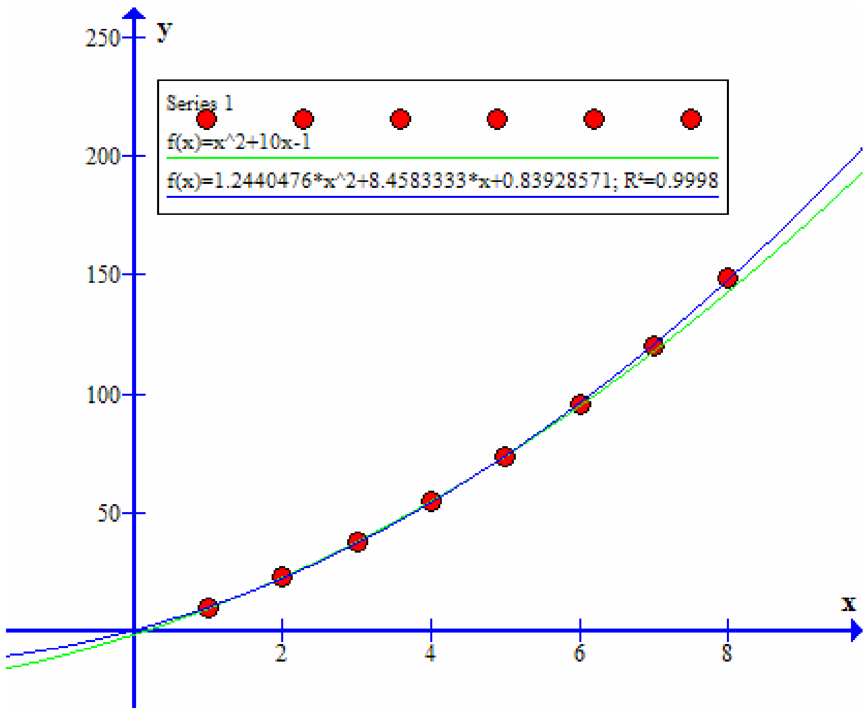


From the graph it is visible that all the points almost fit the function exactly. However the lack of correspondence is very limited but not a single point fits the curve exactly whereas the first equation that was found using matrix method fits the first five points perfectly. This is proved by calculating points from the function (see table below)

x	Guide number (from tip)	1	2	3	4	5	6	7	8
y	Distance from tip (cm)	10	23	38	55	74	96	120	149
$y = 1.2440476x^2 + 8.4583333x + 0.83928571$	Distance from tip (cm)	10.5417	22.7321	37.4107	54.5774	74.2321	96.375	121.006	148.125

This allows for a conclusion to be made that the function $y = 1.2440476x^2 + 8.4583333x + 0.83928571$ better fits the model than the $y = x^2 + 10x$ @1 that was proved using the matrix method. Although the first one lacks correspondence with the all of the points it is to a very slight value and can be said that it gives a more reasonable result. Even though $y = x^2 + 10x$ @1 corresponds exactly for the first five points afterwards the correspondence difference grows to a bigger value and the reliability of this function is low (see graph below).

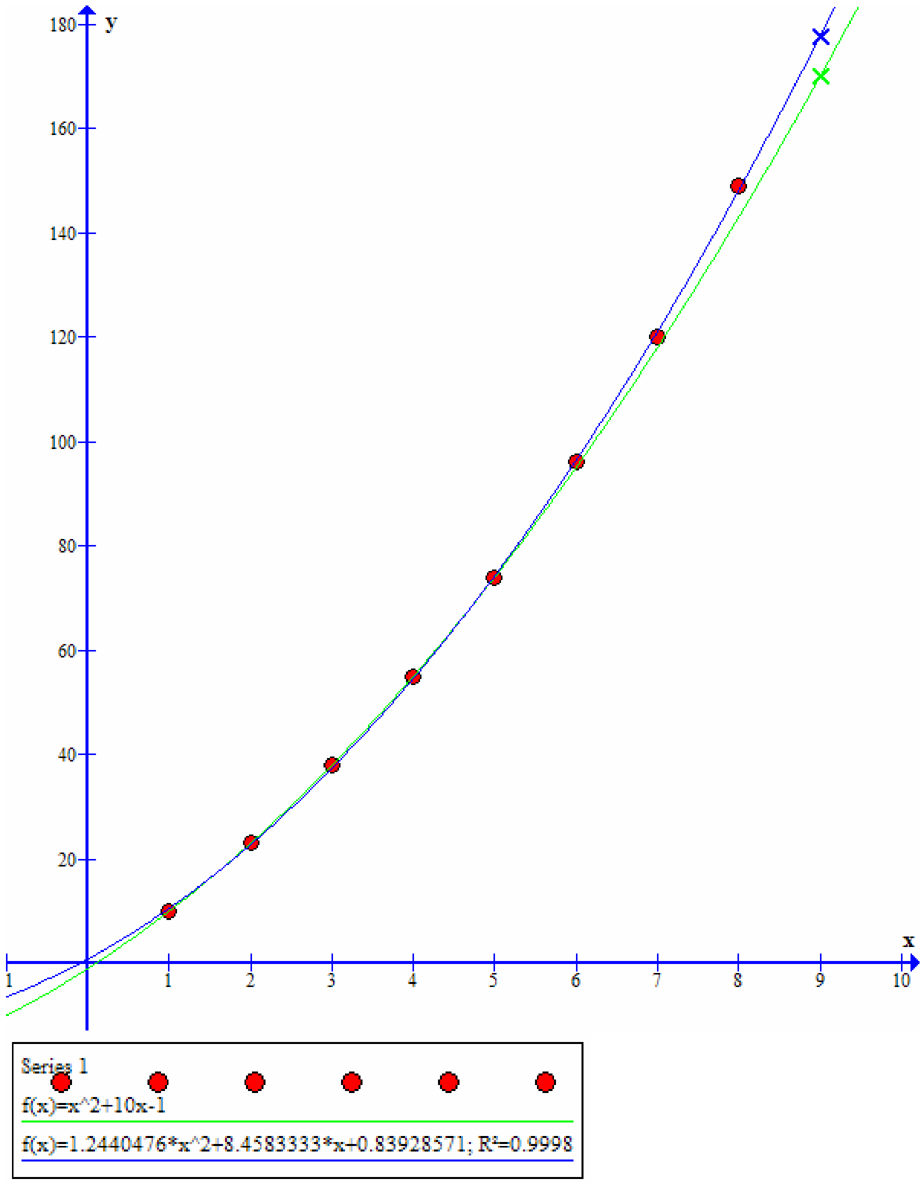
Marked by Teachers
This document was downloaded from www.markedbyteachers.com



x	Guide number (from tip)	1	2	3	4	5	6	7	8
y	Distance from tip (cm)	10	23	38	55	74	96	120	149
$y = 1.2440476x^2 + 8.4583333x + 0.83928571$	Distance from tip (cm)	10.5417	22.7321	37.4107	54.5774	74.2321	96.375	121.006	148.125
$y = x^2 + 10x$ @1	Distance from tip (cm)	10	23	38	55	74	95	118	143

To calculate the guide for point 9 we will have to substitute 9 into the equation(s) $y = x^2 + 10x$ @1 giving the value of 170. The second function $y = 1.2440476x^2 + 8.4583333x + 0.83928571$ gives the value of 177.7321

Marked by Teachers
This document was downloaded from www.markedbyteachers.com



The implication with this is that we cannot with certainty tell where the best place for the 9th point is. This is the limit of the two equations although the one that was proved using the matrix method is much less reliable as stated before and as the graph above proves.

Marked by Teachers

This document was downloaded from www.markedbyteachers.com

The 8 x 8 matrix method:

So far by looking at the points on the graph one could have come to a conclusion that it is a quadratic. The graphing software also came up with a quadratic function that although it was closer it didn't match all points accurately.
If we look at the table we can see that it is a set of 8 coordinates. This explains that 8x8 matrix can be used to satisfy all of the eight points (see below).

$$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 128 & 64 & 32 & 16 & 8 & 4 & 2 & 1 \\ 2187 & 729 & 243 & 81 & 27 & 9 & 3 & 1 \\ 16384 & 4096 & 1024 & 256 & 64 & 16 & 4 & 1 \\ 78125 & 15625 & 3125 & 625 & 125 & 25 & 5 & 1 \\ 279936 & 46656 & 7776 & 1296 & 216 & 36 & 6 & 1 \\ 823543 & 117649 & 16807 & 2401 & 343 & 49 & 7 & 1 \\ 2097152 & 262144 & 32768 & 4096 & 512 & 64 & 8 & 1 \end{bmatrix} \times \begin{bmatrix} a \\ b \\ c \\ d \\ e \\ f \\ g \\ h \end{bmatrix} = \begin{bmatrix} 10 \\ 23 \\ 38 \\ 55 \\ 74 \\ 96 \\ 120 \\ 149 \end{bmatrix}$$

$$\begin{bmatrix} a \\ b \\ c \\ d \\ e \\ f \\ g \\ h \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 128 & 64 & 32 & 16 & 8 & 4 & 2 & 1 \\ 2187 & 729 & 243 & 81 & 27 & 9 & 3 & 1 \\ 16384 & 4096 & 1024 & 256 & 64 & 16 & 4 & 1 \\ 78125 & 15625 & 3125 & 625 & 125 & 25 & 5 & 1 \\ 279936 & 46656 & 7776 & 1296 & 216 & 36 & 6 & 1 \\ 823543 & 117649 & 16807 & 2401 & 343 & 49 & 7 & 1 \\ 2097152 & 262144 & 32768 & 4096 & 512 & 64 & 8 & 1 \end{bmatrix}^{-1} \times \begin{bmatrix} 10 \\ 23 \\ 38 \\ 55 \\ 74 \\ 96 \\ 120 \\ 149 \end{bmatrix} = \begin{bmatrix} 0.0025793651 \\ -0.0777777777 \\ 0.9555555552 \\ -6.152777775 \\ 22.2513888 \\ -43.76944443 \\ 55.79047617 \\ -18.999999999 \end{bmatrix}$$

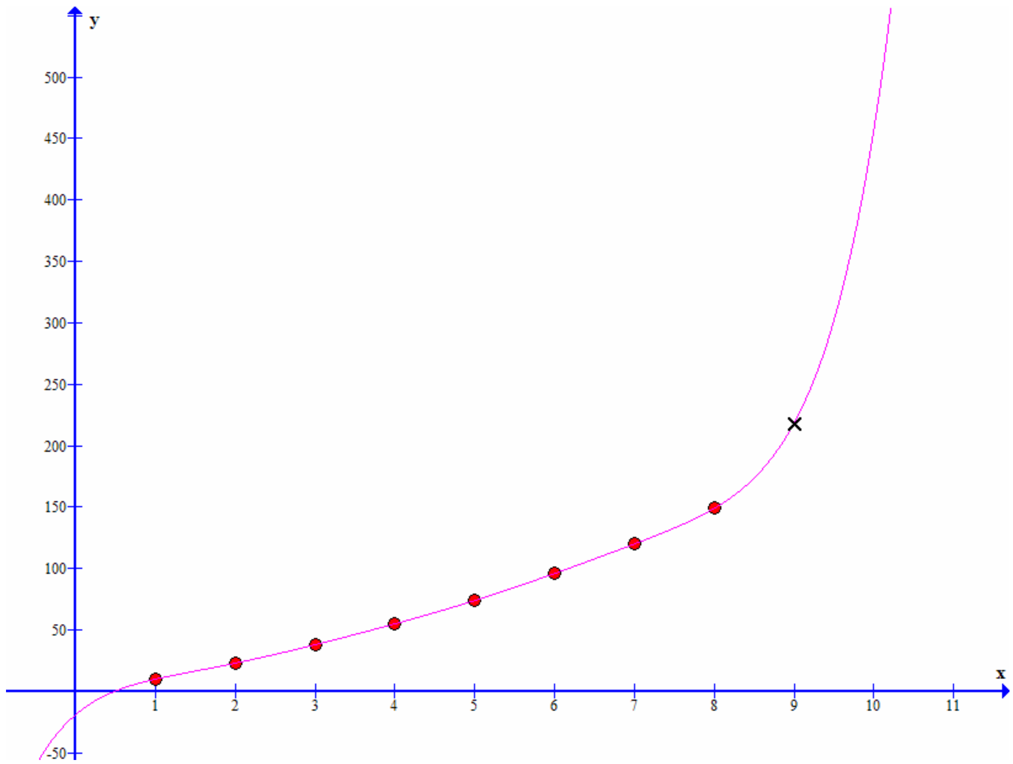
Therefore the equation is

$$0.0025793651x^7 - 0.0777777777x^6 + 0.9555555552x^5 - 6.152777775x^4 + 22.25138888x^3 - 43.76944443x^2 + 55.79047617x - 18.99999999$$

And it gives a graph where the curve meets all 8 points with exact correspondence however the 9th point is very skewed and it doesn't follow the trend. Therefore although this gives accurate results for the first 8 points cannot be used to estimate the 9th point. The table below proves this

x	Guide number (from tip)	1	2	3	4	5	6	7	8	9
y	Distance from tip (cm)	10	23	38	55	74	96	120	149	
$= 1.2440476x^2 + 8.4583333x + 0.8392857$	Distance from tip (cm)	10.5417	22.7321	37.4107	54.5774	74.2321	96.375	121.006	148.125	177.7321
$y = x^2 + 10x - 1$	Distance from tip (cm)	10	23	38	55	74	95	118	143	170
$0.0025793651x^7 - 0.0777777777x^6 \ldots$	Distance from tip (cm)	10	23	38	55	74	95	118	143	218.0001

Marked by Teachers
This document was downloaded from www.markedbyteachers.com



This model can also be used for other fishing rods and not just the model that the work was done on. If we take a look at the following data we can use the same matrix method to come to the needed function that will satisfy the points to a certain extent.

x	Guide number (from tip)	1	2	3	4	5	6	7	8
y	Distance from tip (cm)	10	22	34	48	64	81	102	124

<u>The matrix method:</u>

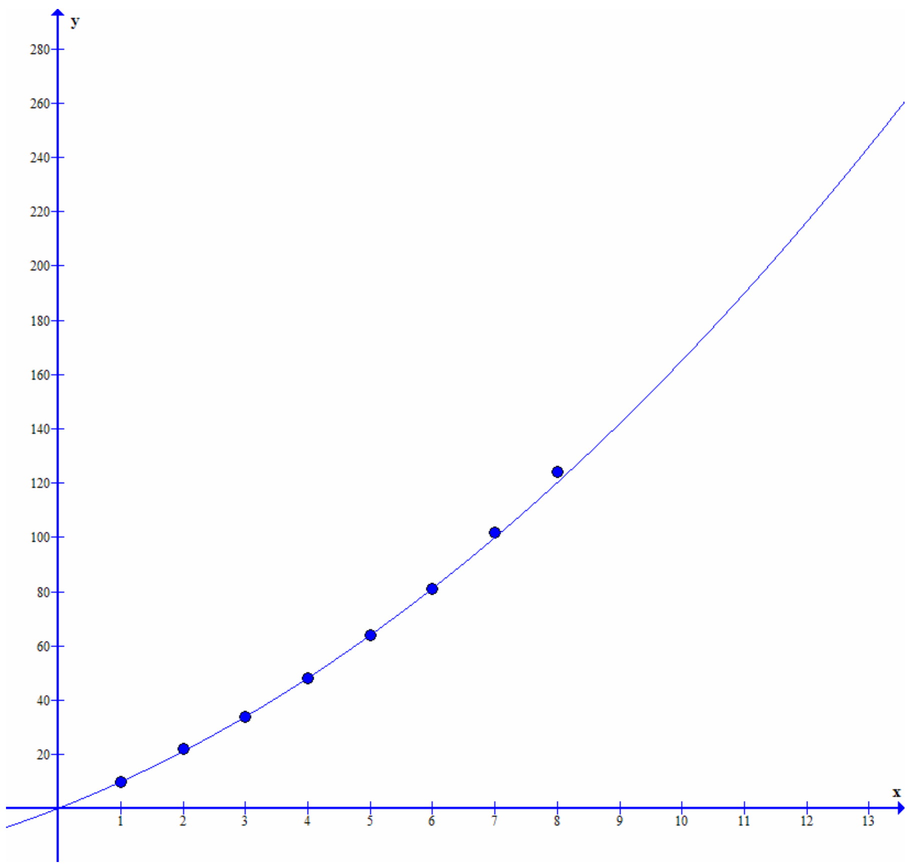
Points: (1,10); (3,34); (5,64)

$a + b + c = 10$
$9a + 3b + c = 34$
$25a + 5b + c = 64$

$$\begin{pmatrix}1&1&1\\9&3&1\\25&5&1\end{pmatrix}\begin{pmatrix}a\\b\\c\end{pmatrix}=\begin{pmatrix}10\\34\\64\end{pmatrix} \Rightarrow \begin{pmatrix}a\\b\\c\end{pmatrix}=\begin{pmatrix}1&1&1\\9&3&1\\25&5&1\end{pmatrix}^{-1}\begin{pmatrix}10\\34\\64\end{pmatrix}=\begin{pmatrix}0.75\\9\\0.25\end{pmatrix}$$

Marked by Teachers
This document was downloaded from www.markedbyteachers.com

Here when using the matrix method we find out that the value for *a* mustn't equal zero because then the function that is a result of that is a linear one which will make the curve completely unreliable and for that reason the values that were used for determining the equation are the 1st 3rd and 5th.



This means that by guessing and trying method one can come to a more reliable result, which will correspond more closely using the matrix method.

Conclusion:

This method is probably used by the factories that make fishing rods. They could use this to manufacture a long lasting rod that would be able to catch many heavy fish and be resistant to breaking or damages. I can see this be used in building of many items that have a spring or other like objects where their endurance needs to be tested. This model seems like a reasonable method to be used by mechanical engineers when observing items so they can be ready to hit the market as a final product.