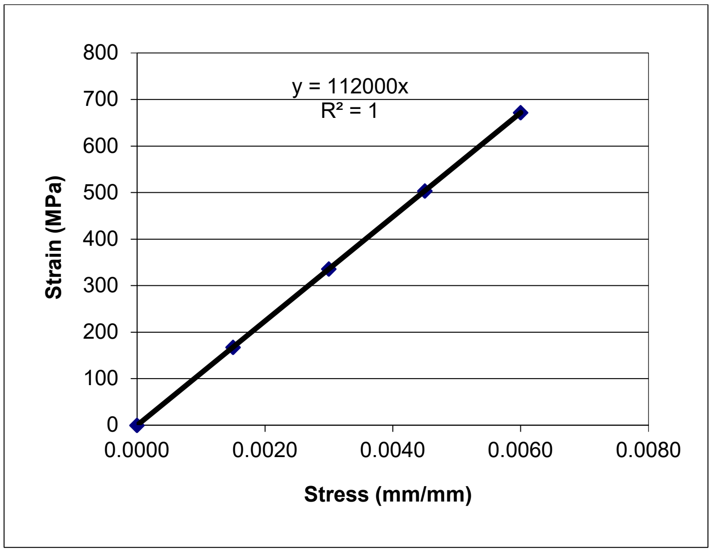
3.1 Stress-Strain Curve II

Stress (mm/mm)	Strain (MPa)
0.0000	0
0.0015	168
0.0030	336
0.0045	504
0.0060	672

Material	Modulus of Elasticity (GPa)
Mg Alloy	45
Al Alloy	70
Ag	71
Ti Alloy	110
Pt	170
SS	200

a)



b) Modulusof elasticity is 112000 MPa, or 112 GPa.

c) Looks like titantium alloy.

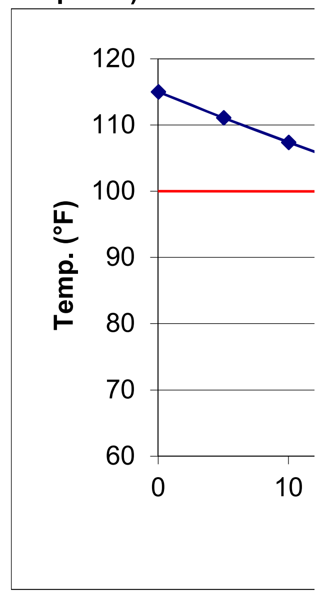
3.2 Tank Temperature During a Wash-Out

T_{in}:	35	°F
V_{dot}:	30	liters/min
V:	3000	liters

a)

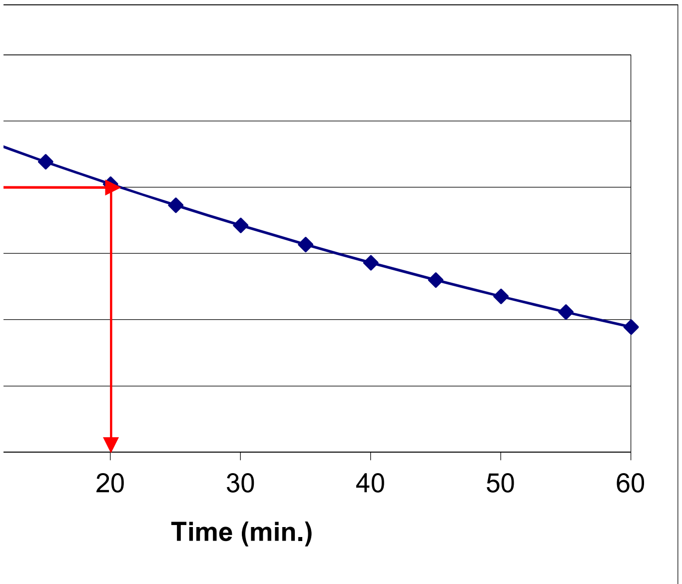
Time (min)	**Temp.** (°F)	
0	115	
5	111	=$C$3-($C$3-$C$9)*EXP(-$C$4/$C$5*B10)
10	107	
15	104	
20	100	
25	97	
30	94	
35	91	
40	89	
45	86	
50	84	
55	81	
60	79	

part b)



c) From the graph, it should take about 20 minutes to cool the hot tub to 100°F.

d) If the tank is not well-mixed, it will depend on where the tank effluent comes out. The cold water flow
If the effluent is at the top of the tank (as pictured), warm water will preferentially leave the tank, and
will be shorter than 20 minutes.



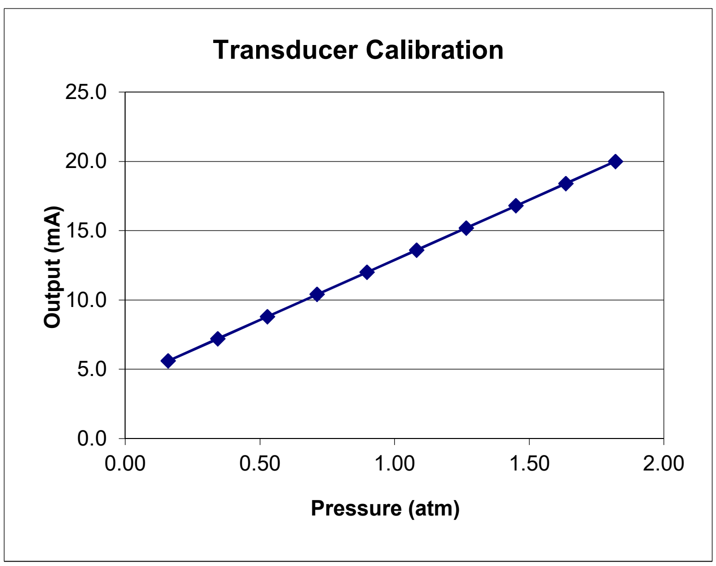
ing in will tend to sink.
the time to cool

3.3 Fluid Statics: Manometer

Mercury Density:	13600	kg/m^3
Oil Density:	880	kg/m^3
Grav. Accel.:	9.8	m/s^2

Calibration Data

Piston Setting	h_L (mm Oil)	Manometer Reading (mm Hg)	Transducer Output (mA)	h_L (m)	Manometer Reading (m)	Pressure (Pa)
1	450	150	5.6	0.45	0.15	16111
2	600	300	7.2	0.60	0.30	34810
3	750	450	8.8	0.75	0.45	53508
4	900	600	10.4	0.90	0.60	72206
5	1050	750	12.0	1.05	0.75	90905
6	1200	900	13.6	1.20	0.90	109603
7	1350	1050	15.2	1.35	1.05	128302
8	1500	1200	16.8	1.50	1.20	147000
9	1650	1350	18.4	1.65	1.35	165698
10	1800	1500	20.0	1.80	1.50	184397



Formulas Used...

h_L (m)	Manometer Reading (m)	
=C11/100(	=D11/1000	=($C$3*
=C12/100(	=D12/1000	=($C$3*
=C13/100(	=D13/1000	=($C$3*
=C14/100(	=D14/1000	=($C$3*
=C15/100(	=D15/1000	=($C$3*
=C16/100(	=D16/1000	=($C$3*
=C17/100(	=D17/1000	=($C$3*
=C18/100(	=D18/1000	=($C$3*
=C19/100(	=D19/1000	=($C$3*
=C20/100(	=D20/1000	=($C$3*

Pressure
(atm)
0.16
0.34
0.53
0.71
0.90
1.08
1.27
1.45
1.64
1.82

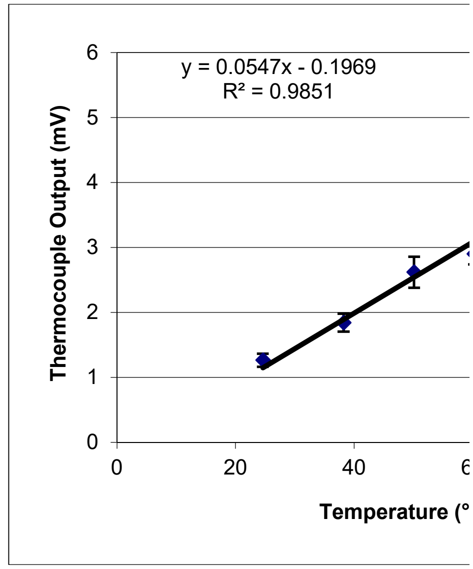
Pressure	Pressure
(Pa)	(atm)
$C$5*H11)-($C$4*$C$5*G11)	=I11/10132
$C$5*H12)-($C$4*$C$5*G12)	=I12/10132
$C$5*H13)-($C$4*$C$5*G13)	=I13/10132
$C$5*H14)-($C$4*$C$5*G14)	=I14/10132
$C$5*H15)-($C$4*$C$5*G15)	=I15/10132
$C$5*H16)-($C$4*$C$5*G16)	=I16/10132
$C$5*H17)-($C$4*$C$5*G17)	=I17/10132
$C$5*H18)-($C$4*$C$5*G18)	=I18/10132
$C$5*H19)-($C$4*$C$5*G19)	=I19/10132
$C$5*H20)-($C$4*$C$5*G20)	=I20/10132

3.4 Thermocouple Calibration Curve

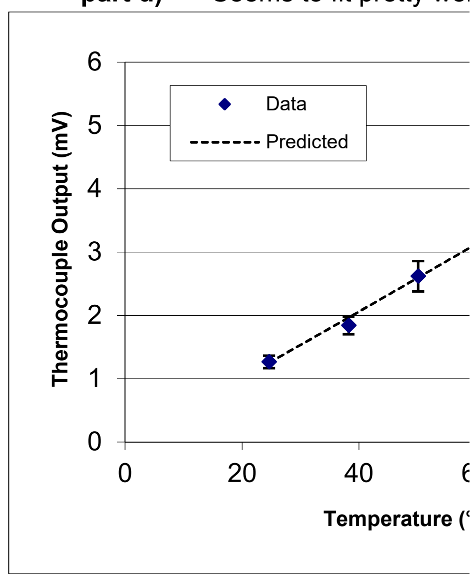
a: 19.741
b: 0.9742

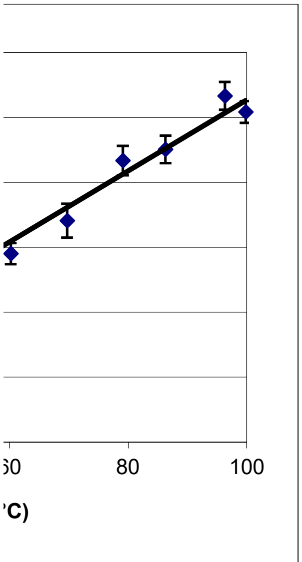
Power Setting	Thermometer (°C)	Thermocouple Average (mV)	Stdev (mV)	Predicted (mV)
0	24.6	1.264	0.100	1.253
1	38.2	1.841	0.138	1.969
2	50.1	2.618	0.240	2.601
3	60.2	2.900	0.164	3.141
4	69.7	3.407	0.260	3.651
5	79.1	4.334	0.225	4.157
6	86.3	4.506	0.212	4.546
7	96.3	5.332	0.216	5.087
8	99.8	5.084	0.168	5.277

parts a, b, c)

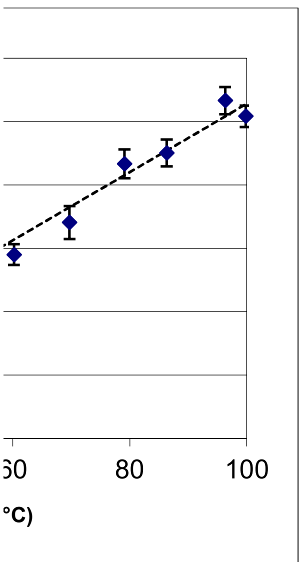


part d) Seems to fit pretty wel





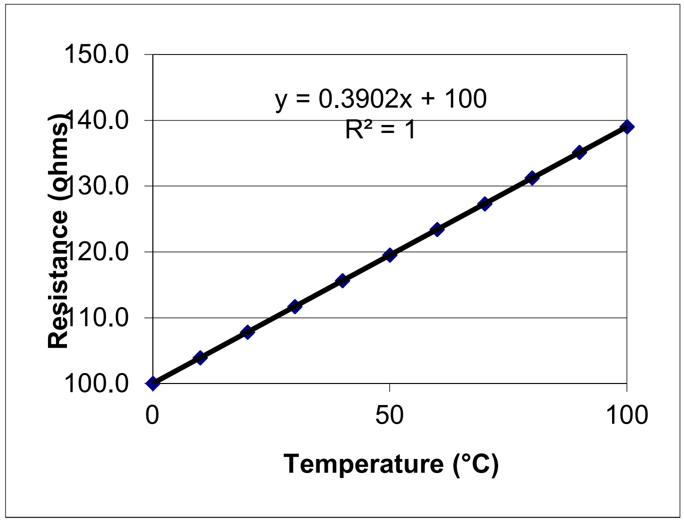
ll.



3.5 Resistance Temperature Detector

Temp.	Resistance
°C	ohms
0	100.0
10	103.9
20	107.8
30	111.7
40	115.6
50	119.5
60	123.4
70	127.3
80	131.2
90	135.1
100	139.0

part a)



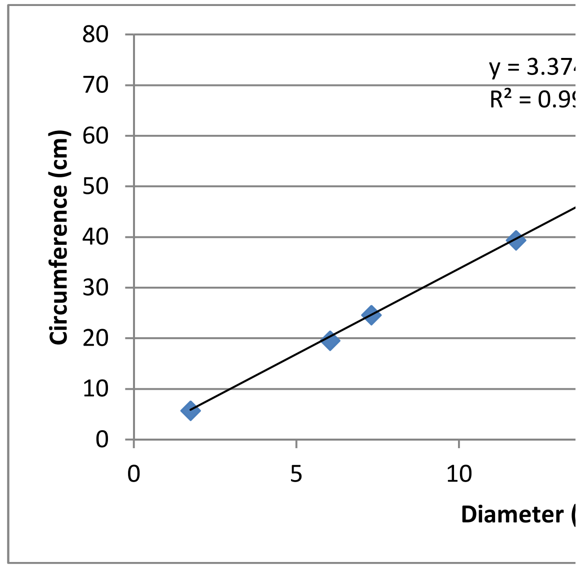
part b) No, it is not laboratory grade.
It is an old RTD using the older grade of platinum.

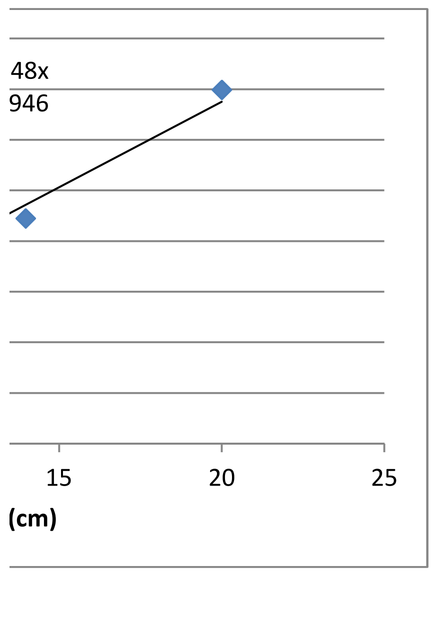
3.6 Experimentally Determining a Value for π

	Diam. (cm)	Circ. (cm)
cup	11.7	39.4
mug	7.3	24.6
pen	1.7	5.7
coffee maker	14.0	44.5
silicon wafer	20.0	69.9
pencil holder	6.0	19.5

Exp. Value:	3.375
Percent Error:	7.4%

Note: There was a conscious effort not to be precise in the measurement of circumference.

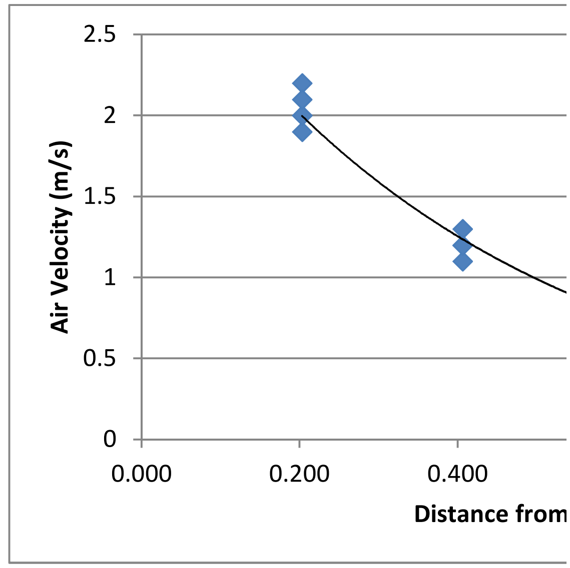




48x
946
15
20
25
(cm)

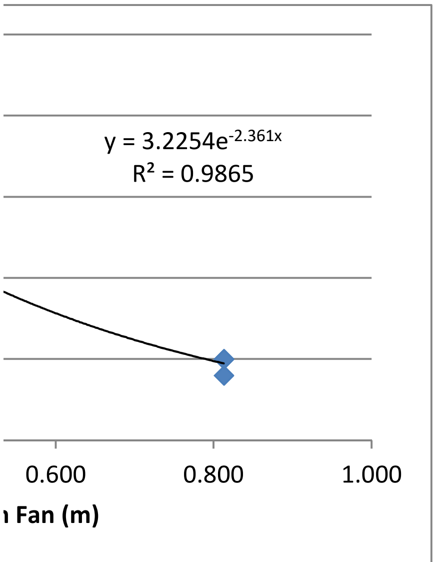
3.7 Predicting Wind Speed

Distance (in)	Distance (m)	Air Vel. (m/s)
8	0.203	2
8	0.203	1.9
8	0.203	2
8	0.203	2.2
8	0.203	2.1
16	0.406	1.3
16	0.406	1.2
16	0.406	1.1
16	0.406	1.2
16	0.406	1.2
32	0.813	0.5
32	0.813	0.4
32	0.813	0.5
32	0.813	0.5
32	0.813	0.5



Predicted Values

Distance (m)	Air Vel. (m/s)
0.3	1.59
0.6	0.78



y = 3.2254e-2.361x
R² = 0.9865
0.600
0.800
1.000
n Fan (m)

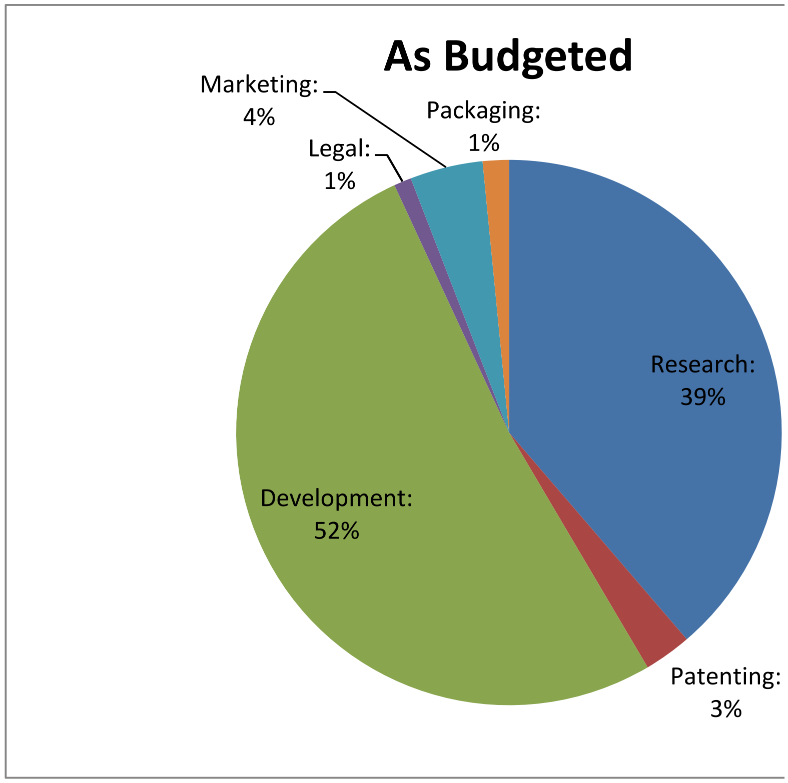
3.8 New Product Development Costs

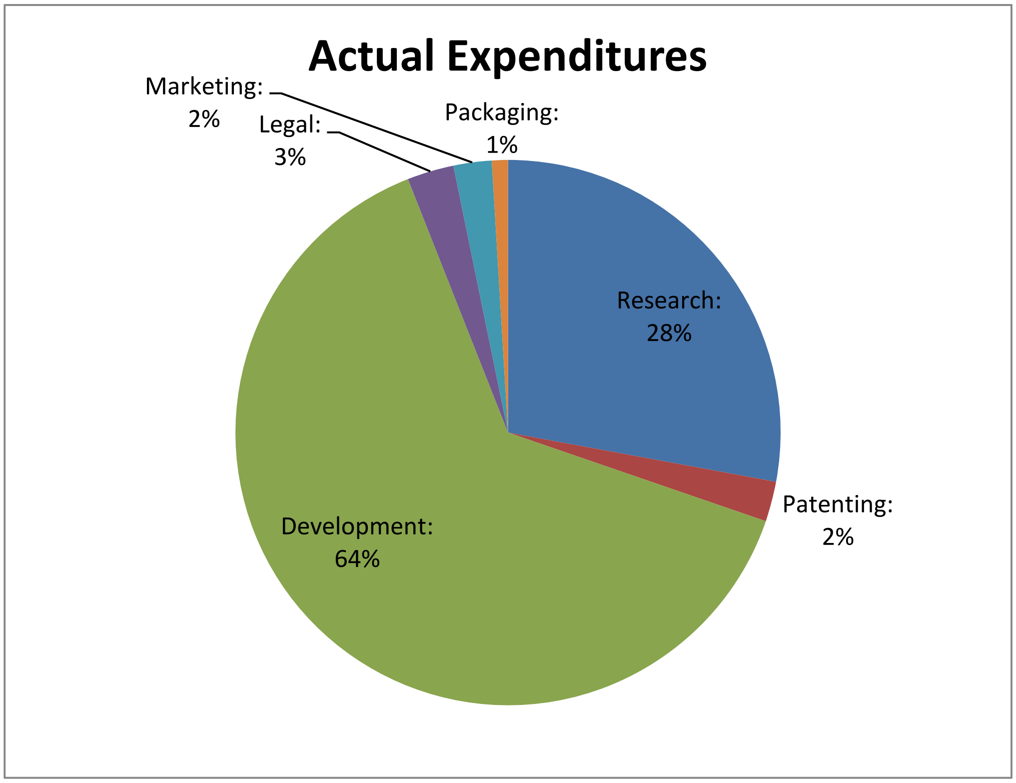
As Budgeted

Research:	$	1,200,000
Patenting:	$	87,000
Development:	$	1,600,000
Legal:	$	32,000
Marketing:	$	134,000
Packaging:	$	48,000
TOTAL:	$	3,101,000

Actual

Research:	$	1,050,000
Patenting:	$	89,000
Development:	$	2,400,000
Legal:	$	104,000
Marketing:	$	85,000
Packaging:	$	36,000
TOTAL:	$	3,764,000

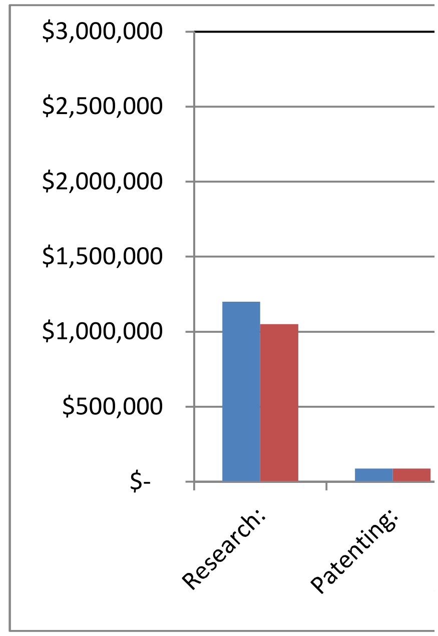


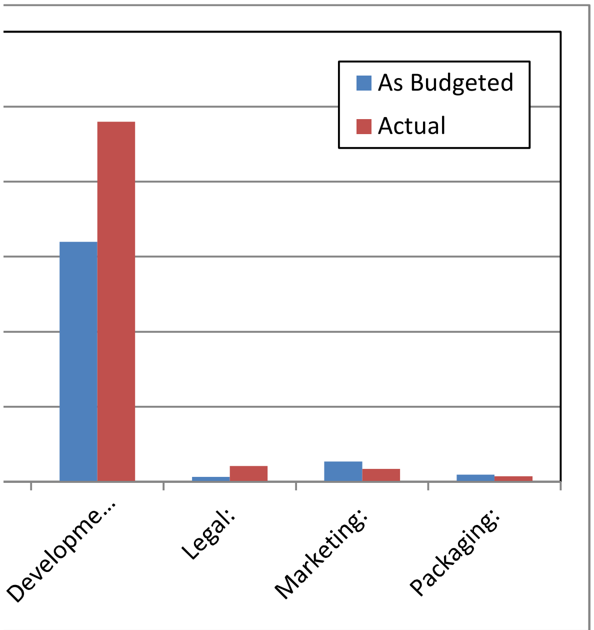


Actual Expenditures
Marketing: 2%
Legal: 3%
Packaging: 1%
Research: 28%
Patenting: 2%
Development: 64%

3.9 New Product Development Costs

	As Budgeted	Actual	% Over
Research:	$ 1,200,000	$ 1,050,000	-12.5%
Patenting:	$ 87,000	$ 89,000	2.3%
Development:	$ 1,600,000	$ 2,400,000	50.0%
Legal:	$ 32,000	$ 104,000	225.0%
Marketing:	$ 134,000	$ 85,000	-36.6%
Packaging:	$ 48,000	$ 36,000	-25.0%
TOTAL:	$ 3,101,000	$ 3,764,000	

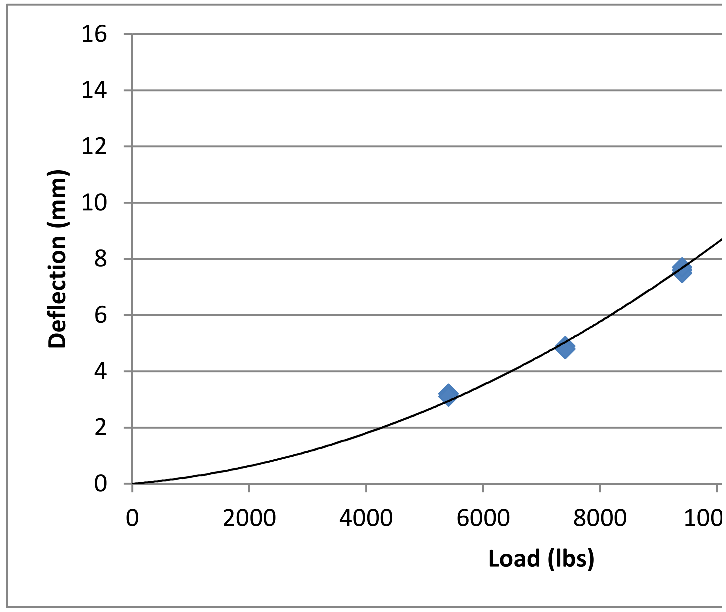




As Budgeted
Actual
Developme...
Legal:
Marketing:
Packaging:

3.10 Bridge Testing

Load (lbs)	Deflection (mm)
5400	3.2
5400	3.2
5400	3.1
7400	4.8
7400	4.9
7400	4.8
9400	7.6
9400	7.5
9400	7.7
11400	10.8
11400	10.9
11400	11.1
13400	broke

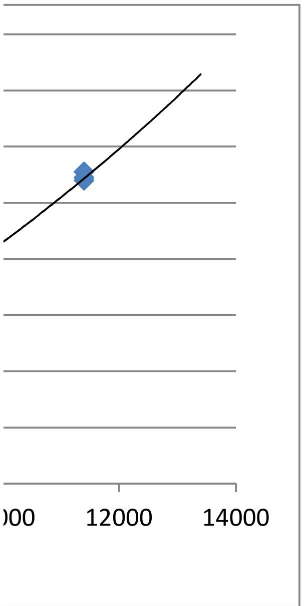


a) Exponential trendline will not allow line to pass through 0 deflection at 0 load.
Linear trendline works, but does not fit data set.
Logarithmic trendline does not fit data set.
Power trendline fits data set well.
Polynomial trendline (order = 2) fits data well and does allow line to pass through 0 de

b) Power and polynomial seem to fit best.

c) Using the Power trendline and forecasting forward 2000 periods to 13400 lb load, the

d) Using a second order polynomial trendline, the predicted deflection at 13400 lb load w
The predicted deflection at 13400 lb load varies quite a bit with type of trendline used.



flection at 0 load.

deflection would have been 14 mr

/ould be 14.7 mm.