Banzai Bicycles

Operations Management

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Company Mission

Banzai Beach Cruiser's vision is to become the number-one bicycle manufacturer in San Diego retail market and other parts of the United States through the online ordering system. We are dedicated to improve the quality of bike riders' recreational experiences with our Southern California beach cruiser-style bicycles. In order to achieve our mission, we are committed to three goals:

- **To our Customers:** We focus on low price and high quality for our bikes in order to ensure customer satisfaction.
- **To our Employees:** We provide a safe, clean, and friendly environment for our employees, to ensure their performance and personal touch remain unmarred.
- **To the Community:** We aim to promote societal wellness, and are involved in many outdoor activities and organizations to meet this desire.

Goals

- Increase sales to 3000 in 2008.
- Reduce manufacturing costs by 30%.
- Lower scrap rate to below 1%.
- Offer an online store, accounting for 20% of our sales.

Corporate Strategies

Products

We currently offer two base models for adults, designed to meet the specifications required for male and female comfort, respectively. Additionally, we offer a variety of bicycle related accessories. These accessories include baskets, alternative seats, custom pedals, and safety equipment.

New Product Plans

We are currently in the process of evaluating the market demand for children's sized bikes. If the market proves to be accessible, we will begin production of children's bikes and bikes accessories in Q4 of '08.

Volume

While we may not be a massive producer of bikes internationally, we limit ourselves to a core set of standard models to ensure quality and consistency in our product. Therefore, we will maintain a relatively high volume of production in relationship to our workforce size, keeping the range of products limited.

Competitive Advantage

Our competitive advantages stem from our price, quality, and relationships with suppliers. By maintaining a positive relationship with suppliers, we ensure we receive the best materials at affordable prices. With these materials in hand, we proceed to turn these materials into the highest quality bicycles, implementing a series of quality checks to ensure their final condition. Finally, by reducing the flaws in our process, we can keep costs low, therefore ensuring high customer value.

Operational Strategies

Improving Productivity

By implementing new quality controls, we will be able to reduce our operating costs while simultaneously increasing our quality assurance. With utilization of new machinery, we will be able to reduce manufacturing time, enabling us to produce more units with more efficiency per unit. The time saved by this operation will allow us to better observe our goods in production, and ensure their compliance with our standards.

Inventory Management

In order to control inventory by reducing the number of parts, and in order to use our workforce effectively, Banzai Beach Cruisers has adopted a product design strategy of standardization. Namely, mass customization where two standardized bicycle frames will be manufactured, but accessories will be picked out by the customer purchasing the bike. This “delayed differentiation” will give customers variety while maintaining the quick, efficient production process of standardization.

In the case of direct sales through the outlet, we will have two styles of bike with standard accessories (i.e. seat, handlebars, etc.). Some will include extras such as baskets or racks.

This will give us many benefits, such as:

- Greater inventory control: two main bicycle frames will be produced and held in inventory until an order comes in with the “customized” features.
- Customers will have variety in their choices of finished bikes.
- Speed of delivery will be fast, almost as if the entire bike were standardized, because the product will be shipped apart in boxes, and the customer will do the actual final assembly, - this means all we will do is take the custom parts from the shelf and box and ship them along with the standard frame.
- We will be able to focus our production runs on the two basic frames.

Our products will be made with XCr seamless, high-grade stainless steel tubing, with a reduced thickness, up to .4mm. This will provide excellent weldability, and most importantly, especially for beach bicycles, a high corrosion resistance, and exceptional resistance to stress corrosion cracking. The reliability and lifecycle of our bikes, due to the quality materials, will best the competitors.

QFD

Making the 26” Beach Cruiser out of steel, we have taken into account bicycle properties that our customers most desire. These are detailed in Figure 1 under the categories of:

- Stiffness
- Strength
- Weight

Stiffness affects the riding qualities of the bike and is determined by a property of the material called “elastic modulus”, which is the amount of flex the metal will give.

Strength relates to the crash-worthiness or general durability of the bike. Strength is determined by “yield strength”. Yield strength is very much affected by the quality of the steel used, which is why we use seamless, high-grade stainless steel tubing.

The weight of a given volume of material is called “specific gravity”. Though steel frames are heavier than others, this weight has been decreased by making the walls of the tubes we use thinner. This makes our steel frame three times as “stiff” as aluminum and twice as stiff as titanium. This replaces the “whippy” feel of lighter bikes with a more comfortable ride.

Some properties of the common frame models are shown in this table:

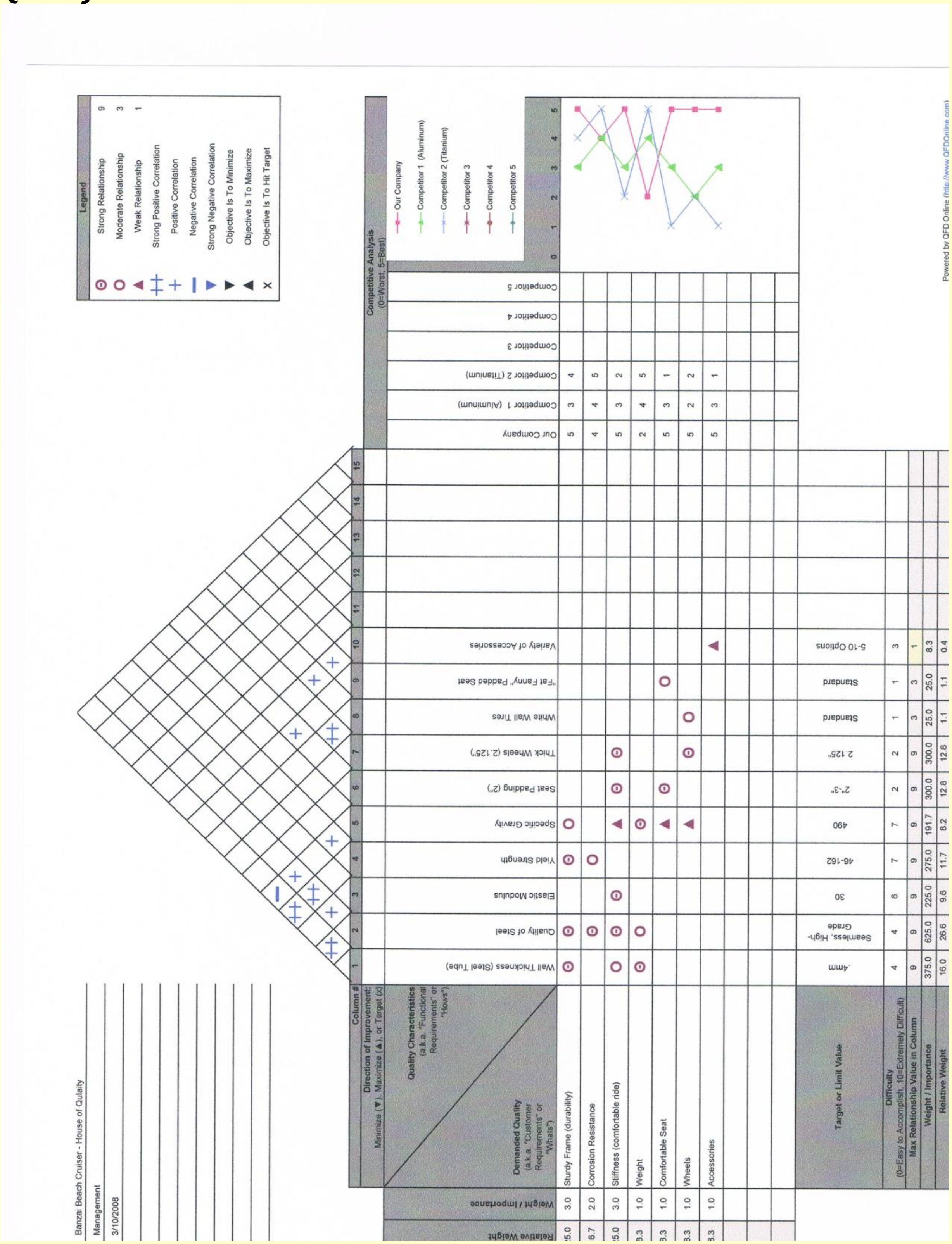
Materials Table

Material	Modulus	Yield Point	Specific Gravity
Aluminum	10-11	11-59	168.5
Steel	30	46-162	490
Titanium	15-16.5	40-120	280

The “yield” values show the aluminum frame would be much weaker. The steel frame would be twice or more stiff (more comfortable). Although the steel frames would be heavier, we’ve lightened them by using finer crafted tubing. The weight adds stability, while still being easily transported.

However, the greatest degree of flex is in the wide, white-walled, tire we use, and secondly in our “Fat Fanny” cruiser seat. This allows us to customize the feel of our bikes to specific customer requests, without being required to custom manufacture a frame for them.

House of Quality



Environment, Legal

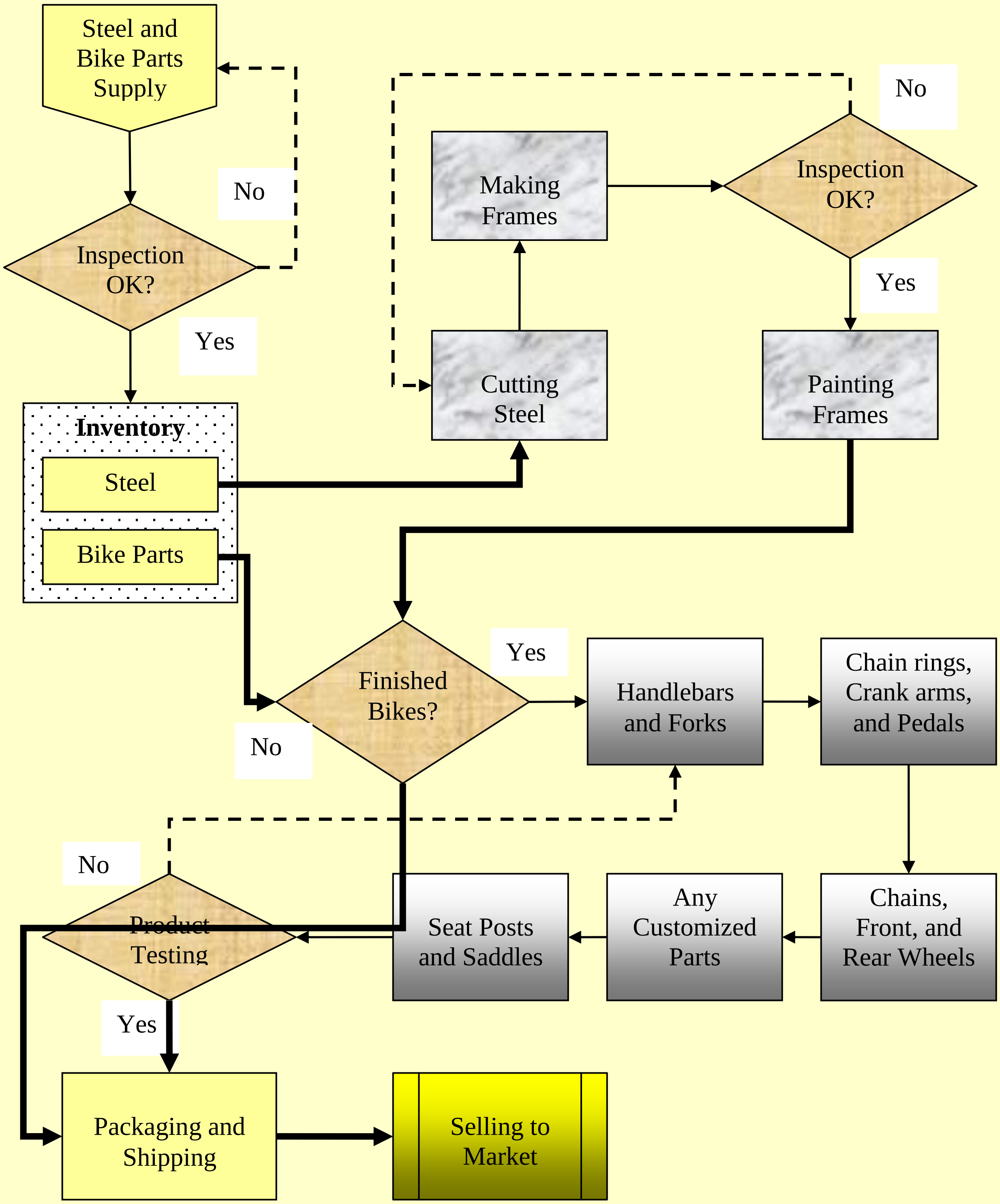
Of no small concern is the environmental impact of our operations. As with any metal processing plant, there are shavings to be disposed of, waste water that is produced to cool the equipment, and various oils and other fluids that risk entrance into the sewer system if not properly taken care of. Also there is the impact on our surroundings, both in air quality from painting and noise from equipment. To ensure these problems are addressed, we will undertake the following steps.

- Our facility will be inspected at regular intervals to ensure compliance with local environmental ordinances.
- All staff will be instructed in proper disposal procedures for waste.
- Recycling initiatives will be utilized, to recover as much of the otherwise discarded materials as is deemed appropriate.
- Our fabrication and assembly area will be appropriately managed to minimize sound pollution, both for the sake of our neighbors and our attached sales area.
- Air filters will be employed around the painting station to make certain that particulates are not escaping and being breathed by our employees, our neighbors, and our customers.

Liability

We understand that we are acting in a litigious society, and we place a great deal of trust upon our quality manufacturing to protect us from suit. Should this not prove sufficient, we have acquired acceptable insurance to allow us to face suits, as well as maintained strong relationships with several local firms in case their expertise should prove necessary.

Manufacturing Process (Figure 2)



Step 1: The first three boxes on the upper left of the flowchart show the process and basic duties of the inventory department. The raw material such as steel and bike parts will come to the inventory department. These steel and bike

parts are inspected carefully because this is the most important step in the process to make sure that we can produce quality bikes and save time for later inspections when bike parts go to the assembly line. Raw material that is not qualified our requests will be returned immediately to its suppliers.

Step 2: There are two thick dark arrow lines going out of the Inventory box to the right. The above line goes up to the Cutting Steel box. It means that the steel will be the input for producing frames of the bikes in the frame cell. The other arrow line going down to the Finished Bike box in the flowchart reveals that bike pats are provided from the inventory department to the assembly line of the parts cell. These parts will be combined with the frames to complete the bikes.

Step 3: Following the thick dark arrow line of the Steel box inside the Inventory box to the Cutting Steel box at the upper right of the flowchart, we examine the third step in the process of making a bike: frame making. Basically, there are there three simple steps of making a frame in the frame cell; that is, cutting steel, making frames, and painting them. In addition, because the coat can cover defects, inspection will take place to check the reliability and durability of the products before painting the frames. However, the inspection will not take long because we use machines to do most of the tasks and we only produce one type of beach bike frames for both men and women.

Step 4: After painting the frames, they will go to the assembly line in the parts cell. The dark arrow going down from the Painting Frames box to the

Finished Bikes diamond box gives this meaning in the flowchart. Instead of putting other parts right away into the frames to continue the process, managers in the parts cell will decide whether they will make finished bikes for retail market or just send separate parts of the bikes to remote customers.

Step 5: If finished bikes are demanded, the process continues. One worker will assemble handlebars and forks; one will put chain rings, crank arms, and pedals; one will gather chains, front wheels, and rear wheels; another worker will handle any customized parts, such as rims, back racks, and front baskets. The final worker will bring together seat posts and saddles to complete the bikes. Lastly, the finished bikes are packed and sold to retail market. On the other hand, if the manager decides that separate parts of bikes will be sent to customers, the frames will not go to the assembly line. Instead, the frames and other bike parts will head to the packaging and shipping department. The shipped packages are accompanied with a detailed manual that instructs final users how to assemble the bikes, and the process ends here.

Process Selection

Because Banzai Beach Cruises focuses on producing beach bikes that are low-priced and simple, we choose the repetitive and assembly processing to meet that goal. We make only two types of bikes: men full-sized and women full-sized bikes with pedal brakes. Repetitive process will allow us to make high volumes of standardized bikes, so that we can reduce the cost per unit of the products.

Facilities Layout

We use the cellular product layout to design our factory. There are two main cells in this layout: frame cell and parts cell. The frame cell consists of four workstations making one type of frames for both men and women bikes. These stations are cutting steel, making frames, inspecting frames, and coating frames. The parts cell includes an assembly line to complete the bikes and a product testing unit. Indeed, the two production cells are the ones that actually add value to the product. The assembly line in this cell is arranged to U-Shaped line that saves factory space and shortens walking distance from one station to another station. For example, if workers are finished assembling their bike parts, they can go to other stations to help other workers quickly and conveniently.

In addition to two production cells in the factory, there are inventory department and packaging & shipping department. The inventory department is responsible for receiving raw material, such as steel to make the frames and bike parts to assemble finished bikes. The packaging and shipping department is responsible for sending the products to retails and final users.

Facility Location

As a result of the manufacturing process, the location of the company will be at 123 South Front Street, La Jolla. This place is not too far from the San Diego City to take advantage of the labor and the market. Our factory needs low- to middle-skilled workers to operate machines and assemble bike parts. Moreover, the noise of cutting steel could affect the residents in the area. The need of using water for cooling down hot frames and dumping it make us select this site. In addition, we are concerned about the air quality because we have a process of painting the bike frames.

Due to these concerns, we have found this facility to be ideal. Since we are not in the process of heavy manufacturing, our position attached to our storefront allows us to optimize our location usage. Without heavy processing of hazardous materials, we are not required by the La Jolla officials to be located in an industrial zoned complex.

Quality Management

Dimensions of Product Quality

Banzai Bikes has grown from a small family run shop to a thriving supplier of quality beach bikes due primarily to our insistence on quality. Everything from the materials we use to the parts we purchase undergoes strict supervision during our entire process to ensure nothing short of perfection is delivered to our customer. We realize that there are many suppliers of bikes in the world, and with the increasingly global marketplace all are competition, and we set ourselves apart by providing superior quality based on the following criteria.

- By ensuring our machine tooled parts meet exacting specifications, we can ensure that our bikes will fit together properly, without a need for individual adjustments to every frame.
- We purchase raw materials to be processed only from quality suppliers who can provide a history of their quality and practice a commitment to continuing this history of quality.
- Using outside sources for completed chains, rubber grips, and other precision parts, we can dedicate ourselves to the focus needed to construction of key parts.
- Our assembly line is constantly supervised to ensure that pieces in the process of fabrication are given the attention that they require.
- Extensive observations by efficiency consultants have been performed to

provide us with the information on how long each part of our fabrication and assembly process should take, with additional time allowed for deviances in order to not rush our employees.

- All of our station managers must sign off on the parts that move through our production floor, signifying that they approve of the part and are responsible if it is found to be flawed and require retooling.
- Our factory has been designed with safety in mind, allowing workers to do their jobs without fear of unnecessarily dangerous equipment.
- We stand by our warranty and have maintained a rate of 99% customer satisfaction through the years.
- By providing incentives for our customers to give us feedback, good or bad, in the form of coupons for accessory goods, we continually communicate with the customer our dedication to quality and discover any perceived faults with our product, so that they may be corrected as soon as they are discovered.
- Via utilization of advanced Computer Aided Design software, we can determine with accuracy the fit and fabrication required for our final products.
- By sending trained technicians to our suppliers on irregular (i.e. Random) visits, we confirm that only the best quality materials are integrated into our bikes.

- Every batch of parts purchased is tested via exacting measurements to determine it meets our high standards before being paired to a unit on the line.

Quality as a Competitive Advantage

In business we could differentiate our bikes by price, or promotion, or by how and where they are available. Instead, we would rather focus on our product, and on providing our customers with the best quality on bikes for reasonable prices. By making every bike with an eye towards quality, we provide the customer with superior value, and aim for repeat sales through customer recommendation.

Philosophies on Quality

Since quality is such an important part of our process here at Banzai Bicycles, we are absolutely certain in our dedication to passing this commitment along to our employees. By hiring motivated employees as our first step, we seek to keep our staff in a receptive state of mind. Extensive training will take place before employees are set to work the machinery, with every employee held accountable for his or her work.

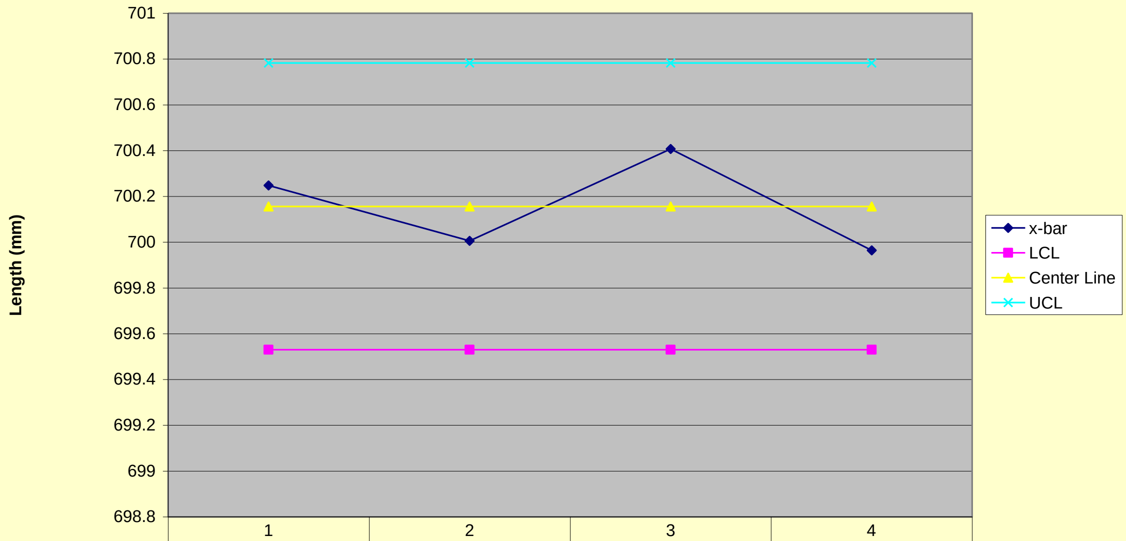
One of the primary tools for this will be employee inspection of completed parts. As every employee will be required to sign off on pieces that they have worked on, and will be trained in spotting defects in the completed unit, employees will not be penalized for setting a part to be retooled if it is not in a condition to be incorporated into the final unit. We wish to ensure that our workers understand this, and do not ever feel the need to pass a part simply to meet a quota. Such practices are far more damaging in the long run than a temporary slow down.

Quality Control

Quality Tools

By utilizing X, R and C-Charts, we strive to confirm that our manufacturing tools are not mis-calibrated or overstressed, causing random variations in our pieces. Every day, a unit is pulled aside at each station to be tested, with the results recorded. Below is a series of recorded results spanning four days, shown in figures (3-X), with attached observation data. Further information can be found in Appendix A.

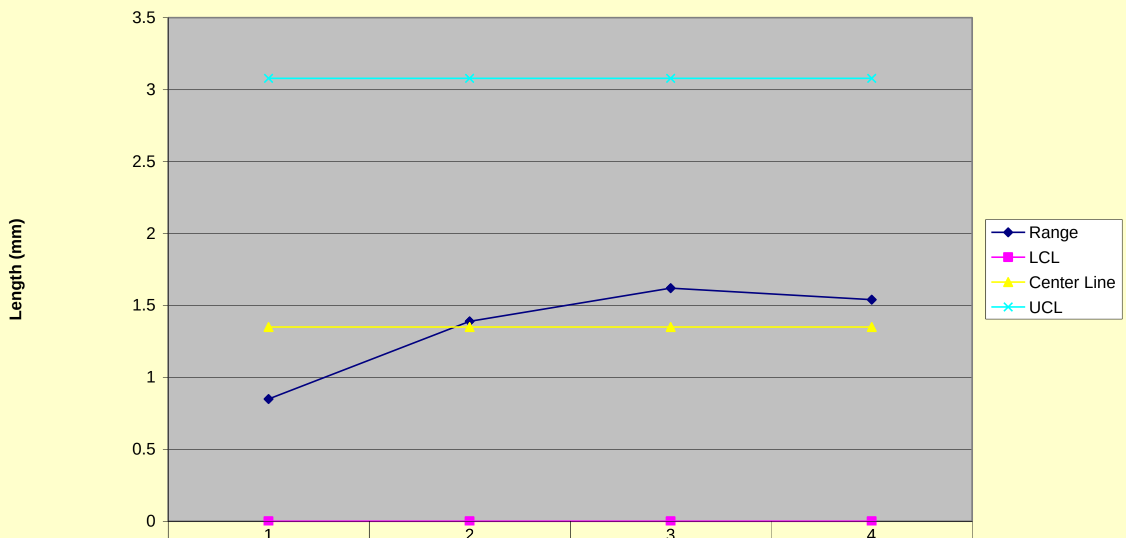
Down Tube X-Bar Chart (Figure 3)



	1	2	3	4
x-bar	700.248	700.006	700.407	699.964
LCL	699.5297628	699.5297628	699.5297628	699.5297628
Center Line	700.15625	700.15625	700.15625	700.15625
UCL	700.7827372	700.7827372	700.7827372	700.7827372

Observation

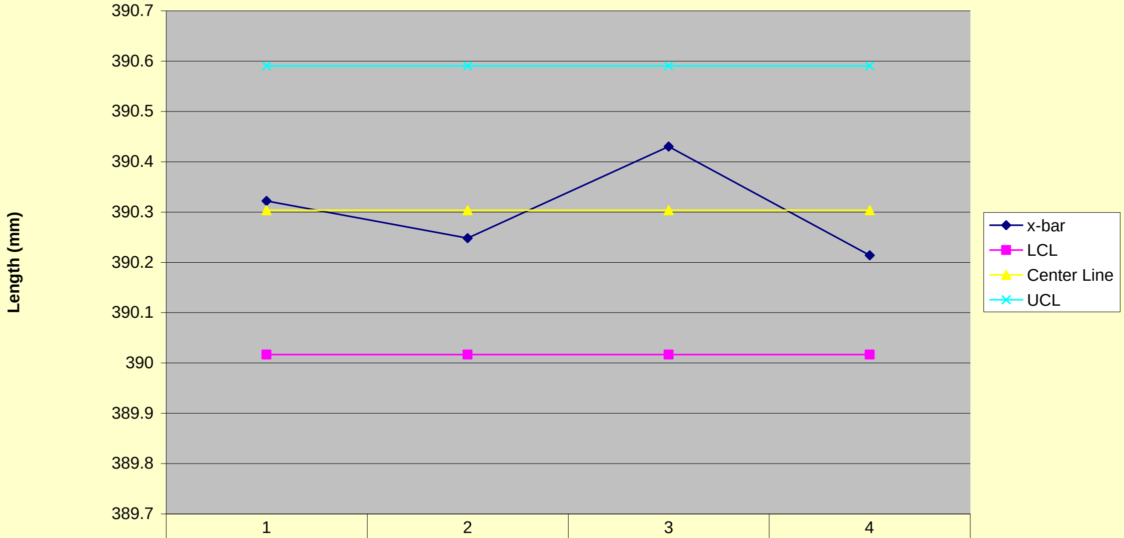
Down Tube R-Chart (Figure 4)



	1	2	3	4
Range	0.85	1.39	1.62	1.54
LCL	0	0	0	0
Center Line	1.35	1.35	1.35	1.35
UCL	3.078	3.078	3.078	3.078

Observation

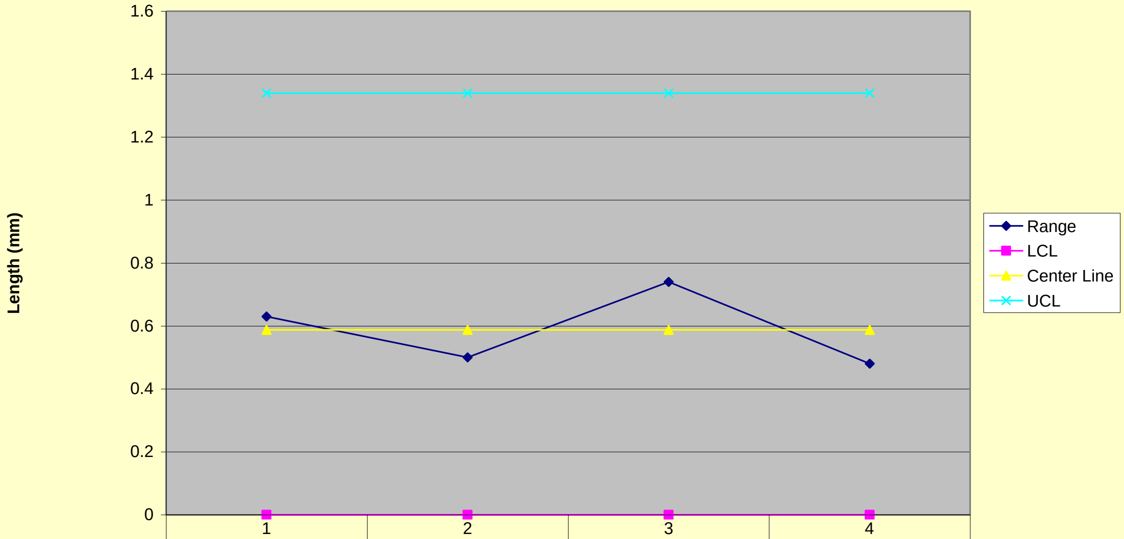
Chain Stay X-Bar Chart (Figure 5)



	1	2	3	4
x-bar	390.322	390.248	390.43	390.214
LCL	390.0166115	390.0166115	390.0166115	390.0166115
Center Line	390.3035	390.3035	390.3035	390.3035
UCL	390.5903885	390.5903885	390.5903885	390.5903885

Observation

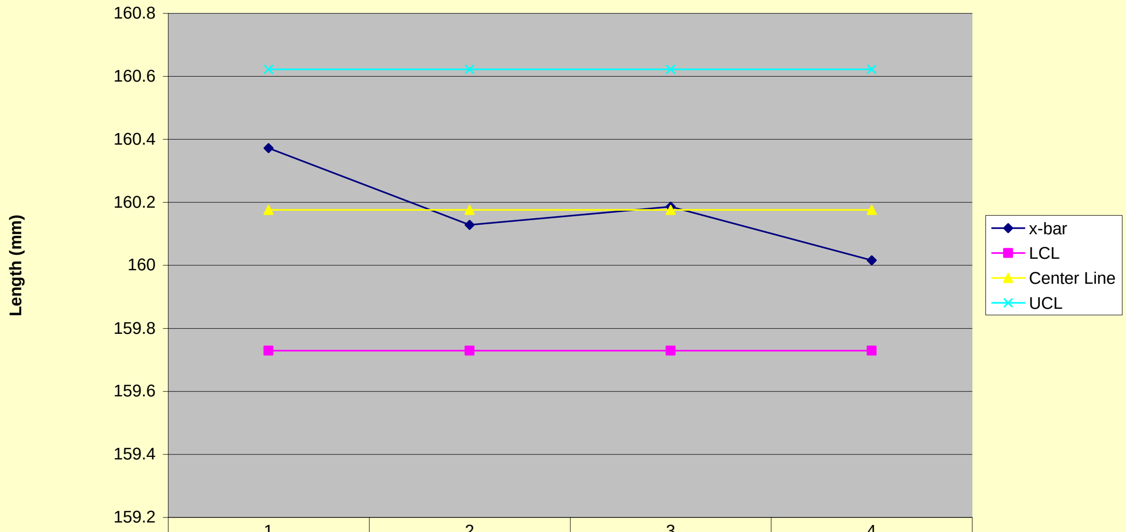
Chain Stay Tube R-Chart (Figure 6)



	1	2	3	4
Range	0.63	0.5	0.74	0.48
LCL	0	0	0	0
Center Line	0.5875	0.5875	0.5875	0.5875
UCL	1.3395	1.3395	1.3395	1.3395

Observation

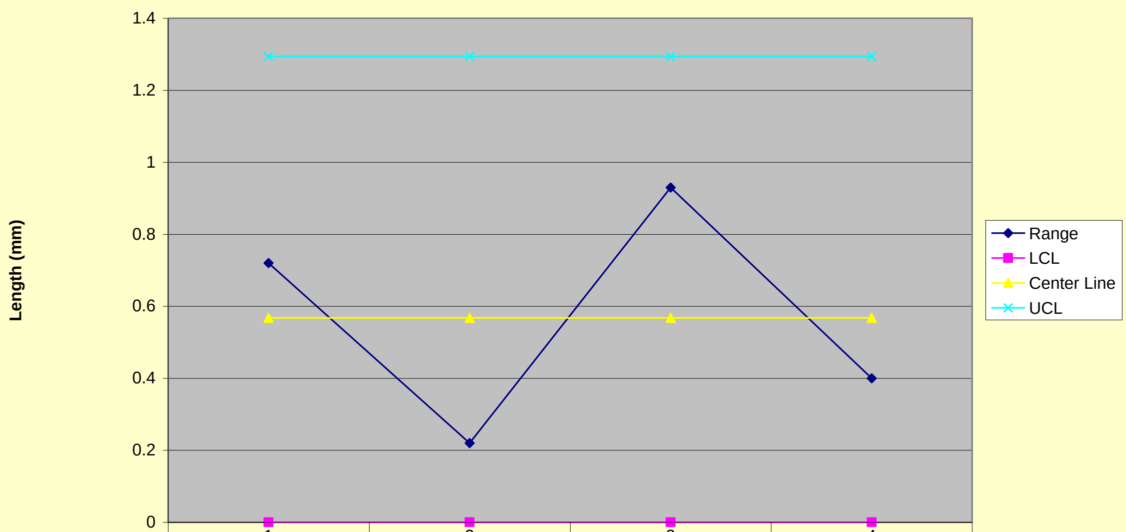
Head Tube X-Bar Chart (Figure 7)



	1	2	3	4
x-bar	160.372	160.128	160.186	160.016
LCL	159.7291179	159.7291179	159.7291179	159.7291179
Center Line	160.1755	160.1755	160.1755	160.1755
UCL	160.6218821	160.6218821	160.6218821	160.6218821

Observation

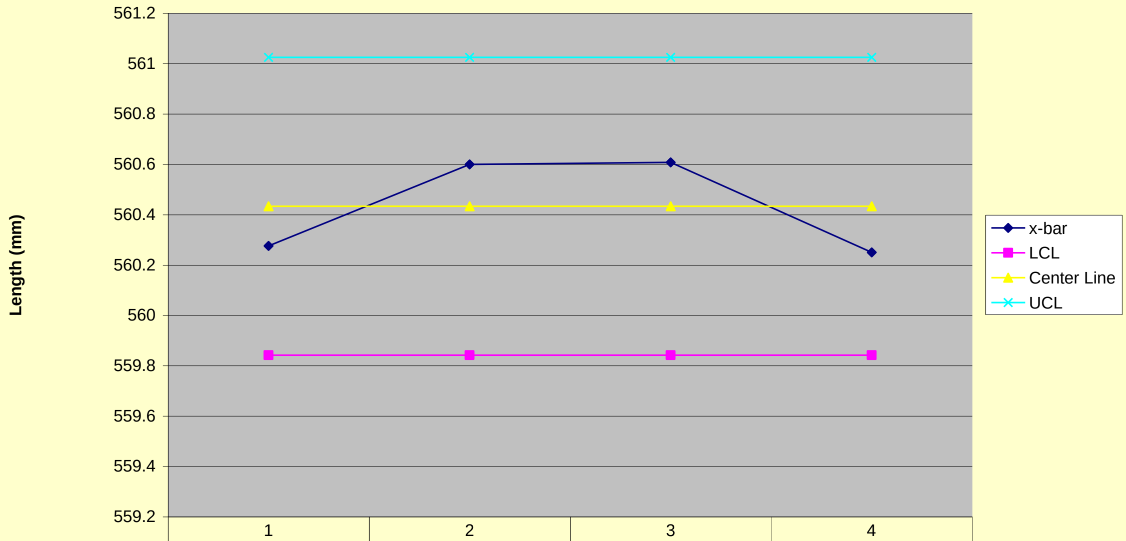
Head Tube R-Chart (Figure 8)



	1	2	3	4
Range	0.72	0.22	0.93	0.4
LCL	0	0	0	0
Center Line	0.5675	0.5675	0.5675	0.5675
UCL	1.2939	1.2939	1.2939	1.2939

Observation

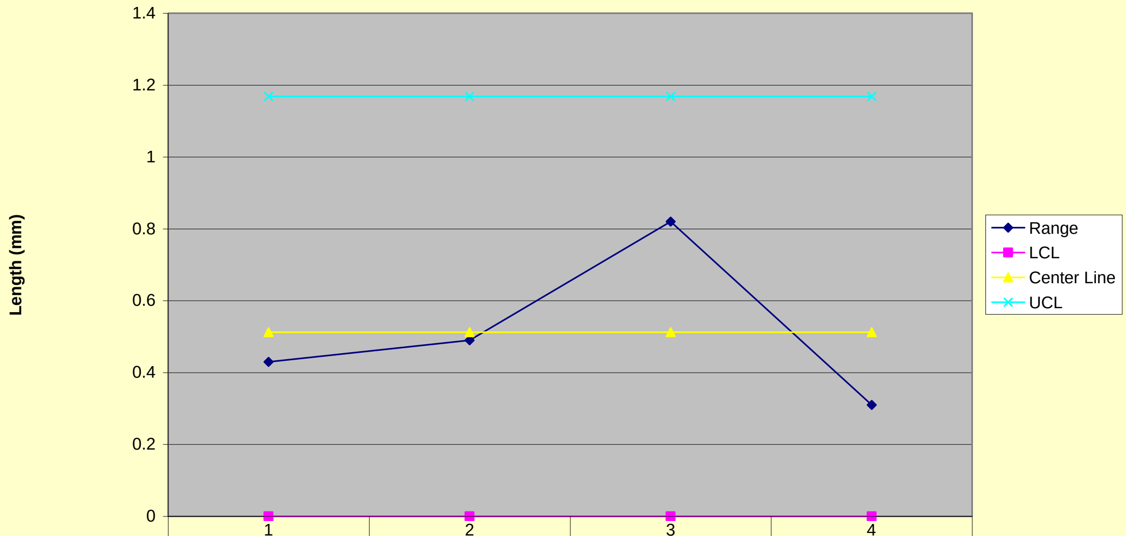
Seat Stay X-Bar Chart (Figure 9)



	1	2	3	4
x-bar	560.276	560.6	560.608	560.25
LCL	559.8419317	559.8419317	559.8419317	559.8419317
Center Line	560.4335	560.4335	560.4335	560.4335
UCL	561.0250683	561.0250683	561.0250683	561.0250683

Observation

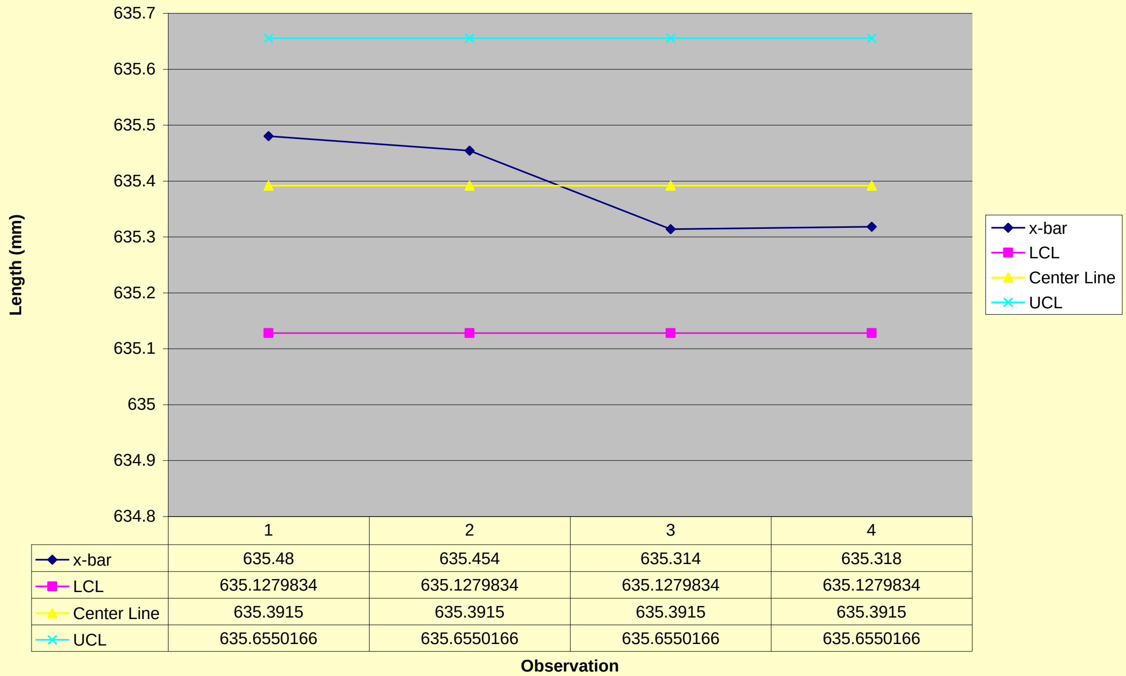
Seat Stay Tube R-Chart (Figure 10)



	1	2	3	4
Range	0.43	0.49	0.82	0.31
LCL	0	0	0	0
Center Line	0.5125	0.5125	0.5125	0.5125
UCL	1.1685	1.1685	1.1685	1.1685

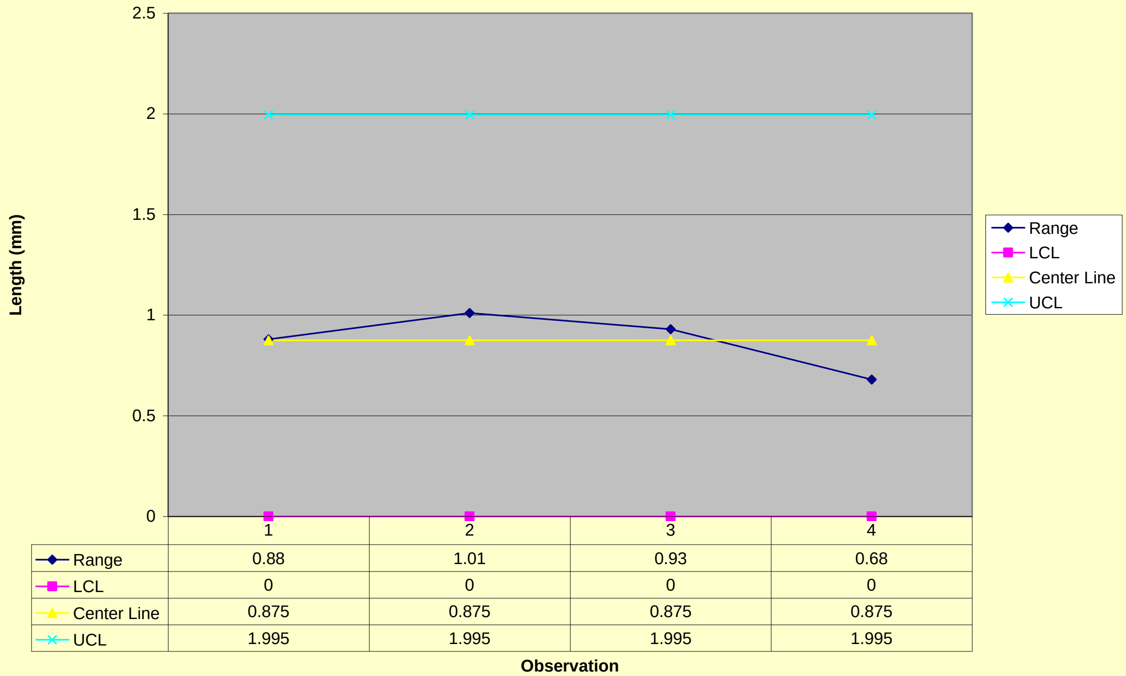
Observation

Seat Tube X-Bar Chart (Figure 11)



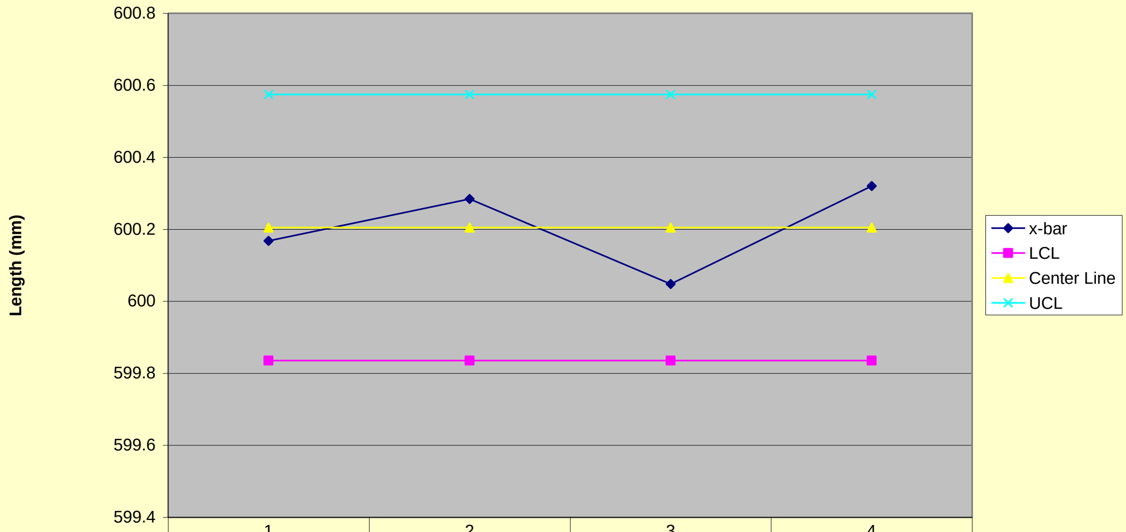
	1	2	3	4
x-bar	635.48	635.454	635.314	635.318
LCL	635.1279834	635.1279834	635.1279834	635.1279834
Center Line	635.3915	635.3915	635.3915	635.3915
UCL	635.6550166	635.6550166	635.6550166	635.6550166

Seat Tube R-Chart (Figure 12)



	1	2	3	4
Range	0.88	1.01	0.93	0.68
LCL	0	0	0	0
Center Line	0.875	0.875	0.875	0.875
UCL	1.995	1.995	1.995	1.995

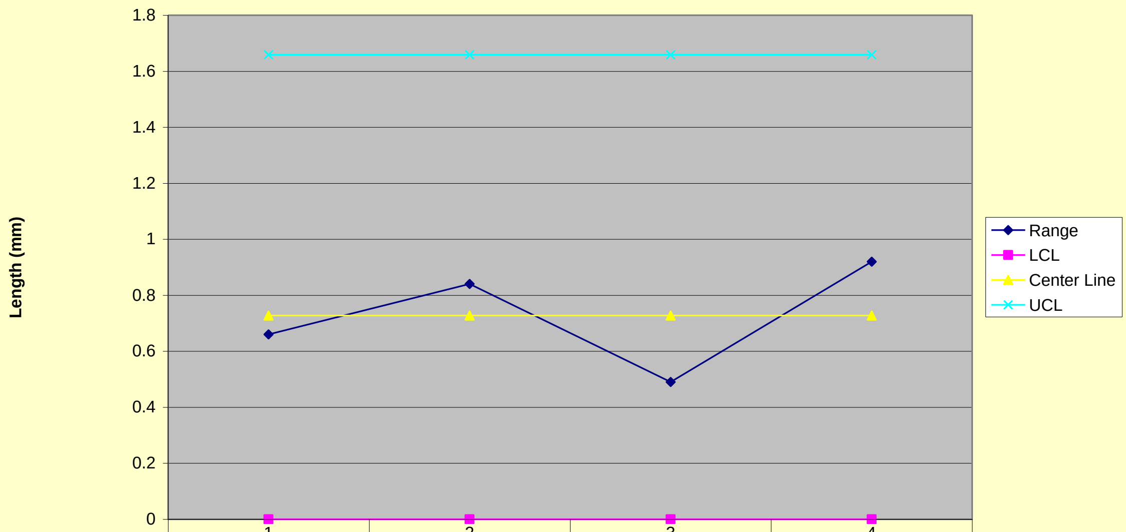
Top Tube X-Bar Chart (Figure 13)



	1	2	3	4
x-bar	600.168	600.284	600.048	600.32
LCL	599.8356059	599.8356059	599.8356059	599.8356059
Center Line	600.205	600.205	600.205	600.205
UCL	600.5743941	600.5743941	600.5743941	600.5743941

Observation

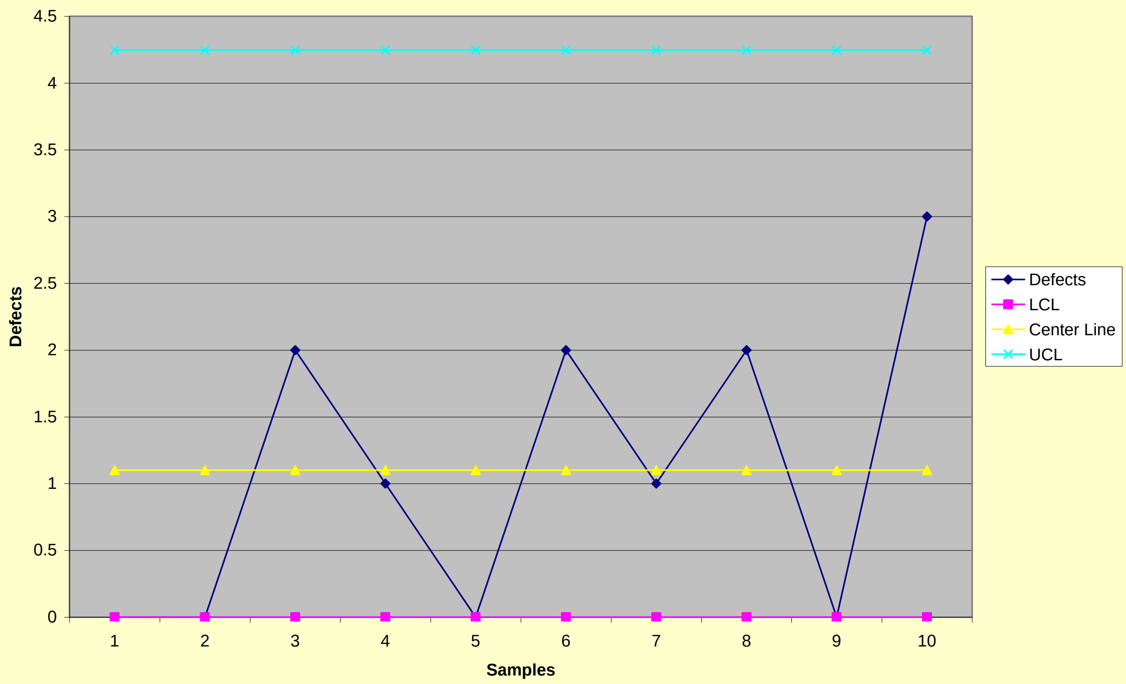
Top Tube R-Chart (Figure 14)



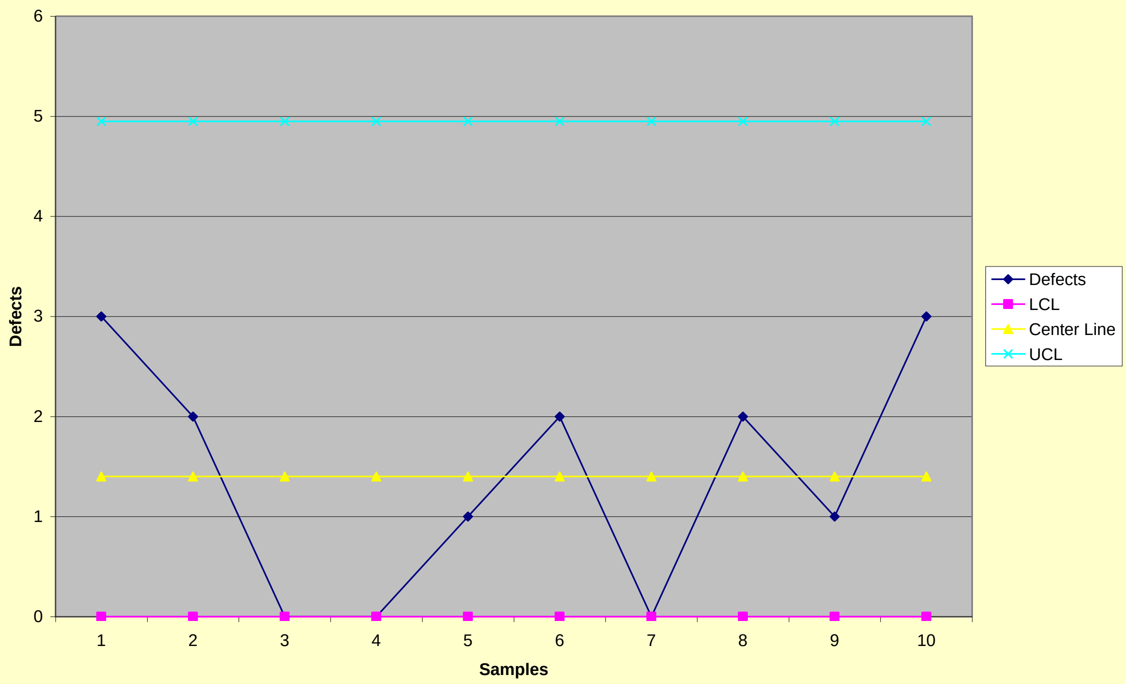
	1	2	3	4
Range	0.66	0.84	0.49	0.92
LCL	0	0	0	0
Center Line	0.7275	0.7275	0.7275	0.7275
UCL	1.6587	1.6587	1.6587	1.6587

Observation

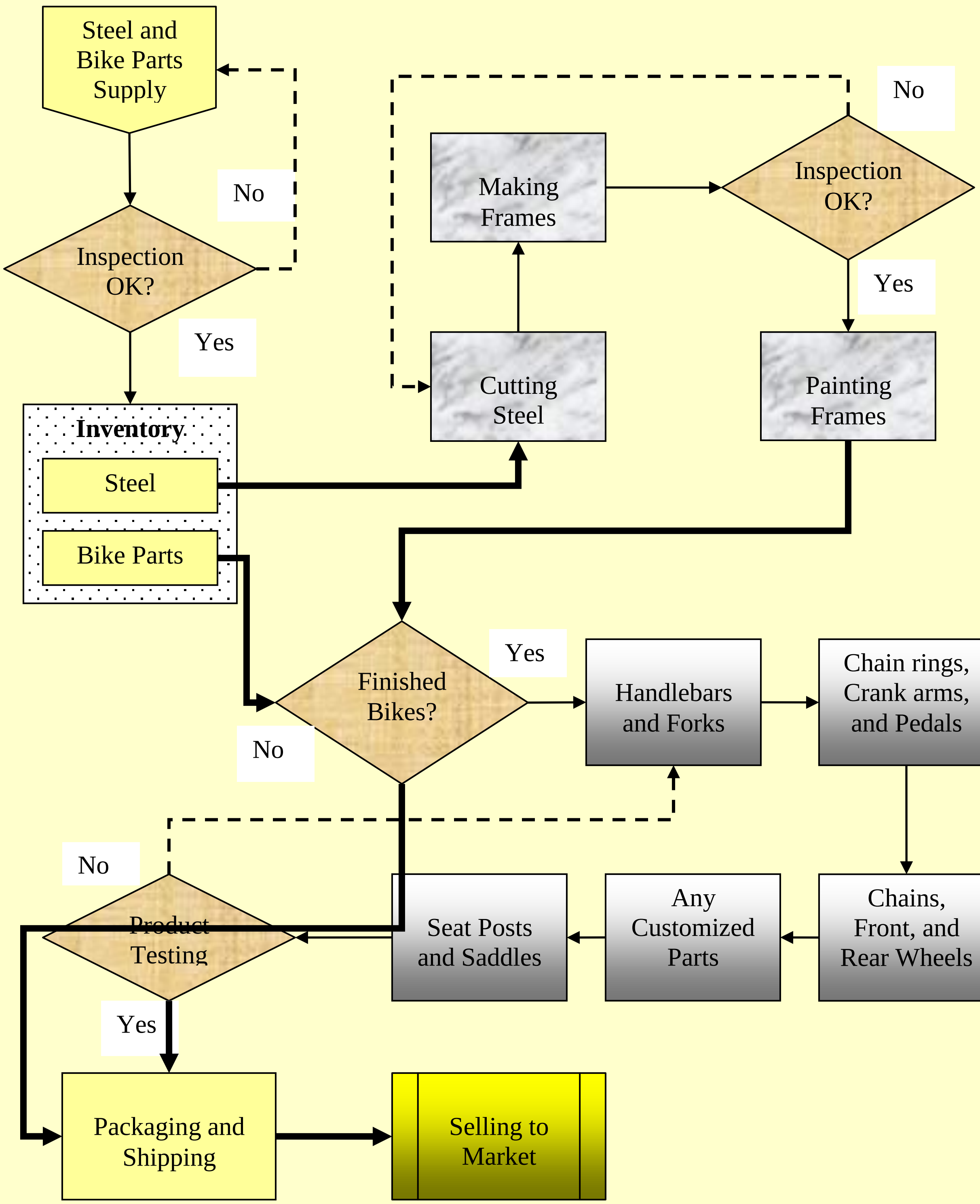
Paint Defects C-Chart (Figure 15)



Welding Defects C-Chart (Figure 16)



Inspection Points (figure 17)



Forecasting

Men's Forecast (Figure 18)

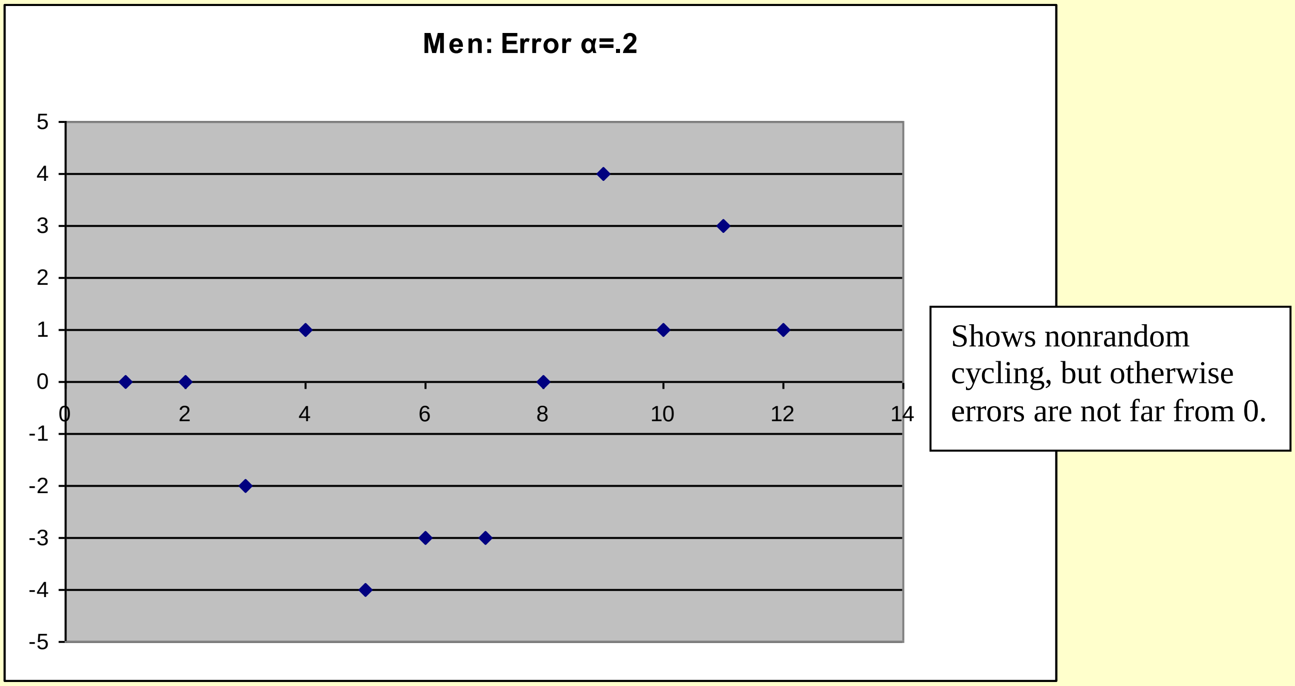
Period	**Actual Demand**	α=.2 Forecast	α=.2 Error	α=.5 Forecast	α=.5 Error	Seasonality α=.2 **Forecast**	Seasonality α=.2 Error	Seasonality α=.5 Forecast	Seasonality α=.5 Error
1	158	154	4	151	7	158	0	155	3
2	164	155	9	155	9	164	0	164	0
3	167	157	10	160	7	169	-2	172	-5
4	180	158	22	166	14	179	1	188	-8
5	164	162	2	173	-9	168	-4	179	-15
6	158	162	-4	169	-11	161	-3	168	-10
7	151	161	-10	164	-13	154	-3	157	-6
8	149	159	-10	158	-9	149	0	148	1
9	164	157	7	154	10	160	4	157	7
10	151	158	-7	159	-8	150	1	151	0
11	145	157	-12	155	-10	142	3	140	5
12	151	155	-4	150	1	150	1	146	5
MA			8.4		9		1.8		4.7

D		2	3	5
MS				50.
E			6	82
			4.9	
UCL			0	
			-	
			4.9	
LCL			0	

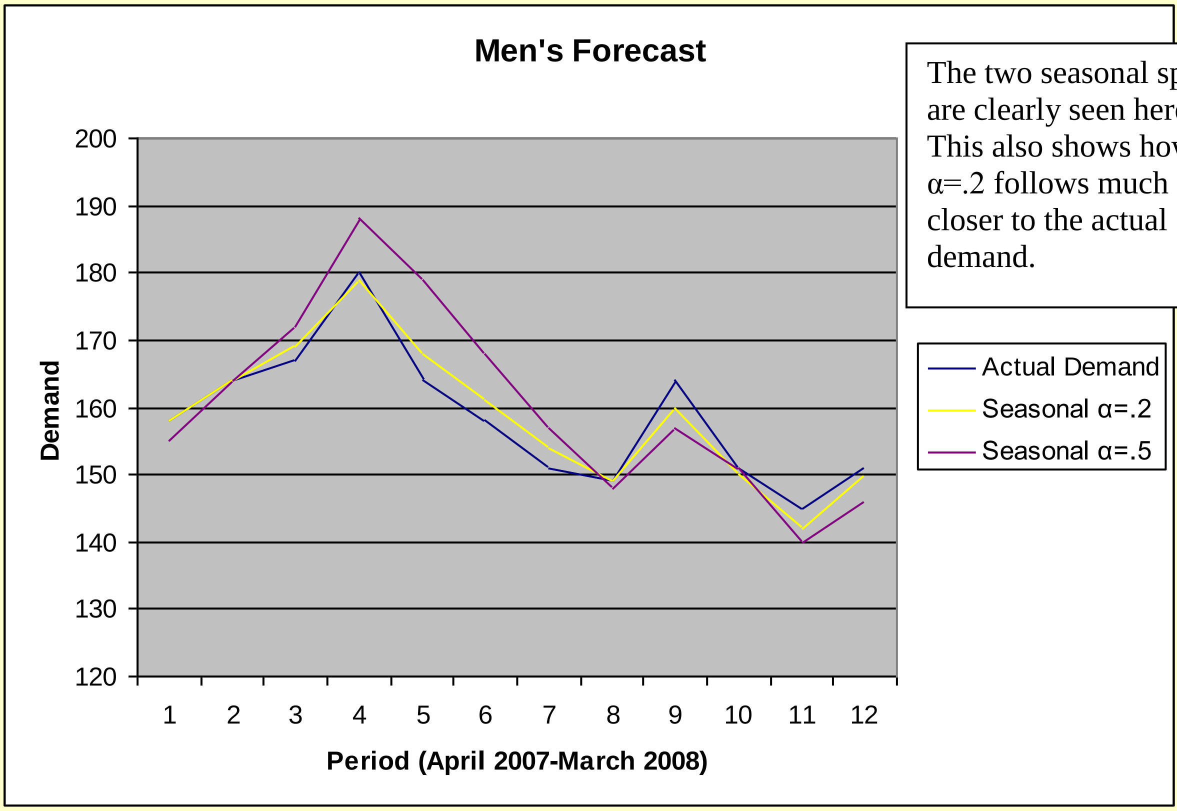
We decided to show graphical representation of the demand during the period from April 2007 through March 2008 because this allows us to clearly see the two obvious seasonal trends—the first peaking in July and the second peaking around Christmas and the New Year. Likely, the most popular New Year's resolutions include some type of fitness regimen, which to us means a higher demand of cruisers.

The seasonal forecast with α=.2 showed a lower range of random variations of errors (yielding a lower MAD and MSE); however, there is still the appearance somewhat of a cycle of non-randomness represented by the control chart, but still less obvious than the cycle of the seasonal forecast with α=.5. We used figures recorded over a span of 30 months in order to use a 12 month moving average, which resulted in less nonrandom errors than that of the 3 and 6 month moving average previous attempted. We can assume that over a much longer period of time we could see this appearance of non-randomness disappearing.

Men’s Forecast Error (Figure 19)



Men’s Forecast Chart (Figure 20)



The two seasonal spikes are clearly seen here. This also shows how α=.2 follows much closer to the actual demand.

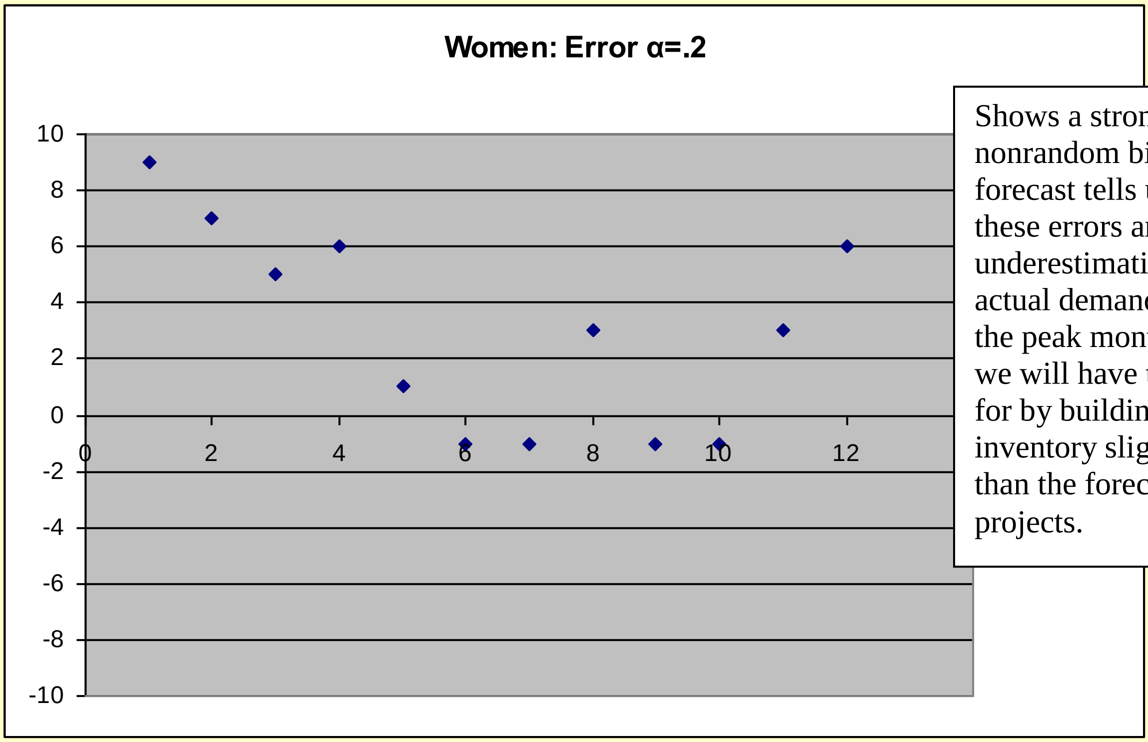
Women's Forecast (Figure 21)

						Seasonality		Seasonality	
		α=.2		α=.5		α=.2		α=.5	
Period	**Actual Demand**	Forecast	Error	Forecast	Error	**Forecast**	Error	Forecast	Error
1	114	113	1	109	5	105	9	101	13
2	127	113	14	112	15	120	7	119	8
3	131	116	15	120	11	126	5	130	1
4	135	111	24	122	13	129	6	142	-7
5	132	116	16	129	3	131	1	145	-13
6	126	119	7	131	-5	127	-1	140	-14
7	119	120	-1	129	-10	120	-1	129	-10
8	118	120	-2	124	-6	115	3	119	-1
9	124	120	4	121	3	125	-1	126	-2
10	104	121	-17	123	-19	105	-1	106	-2
11	99	118	-19	114	-15	96	3	92	7
12	111	114	-3	107	4	105	6	98	13
MAD			10.25		9.08		3.67		7.58

		22.7	88.6
MSE		3	4
UCL		9.54	
		-	
LCL		9.54	

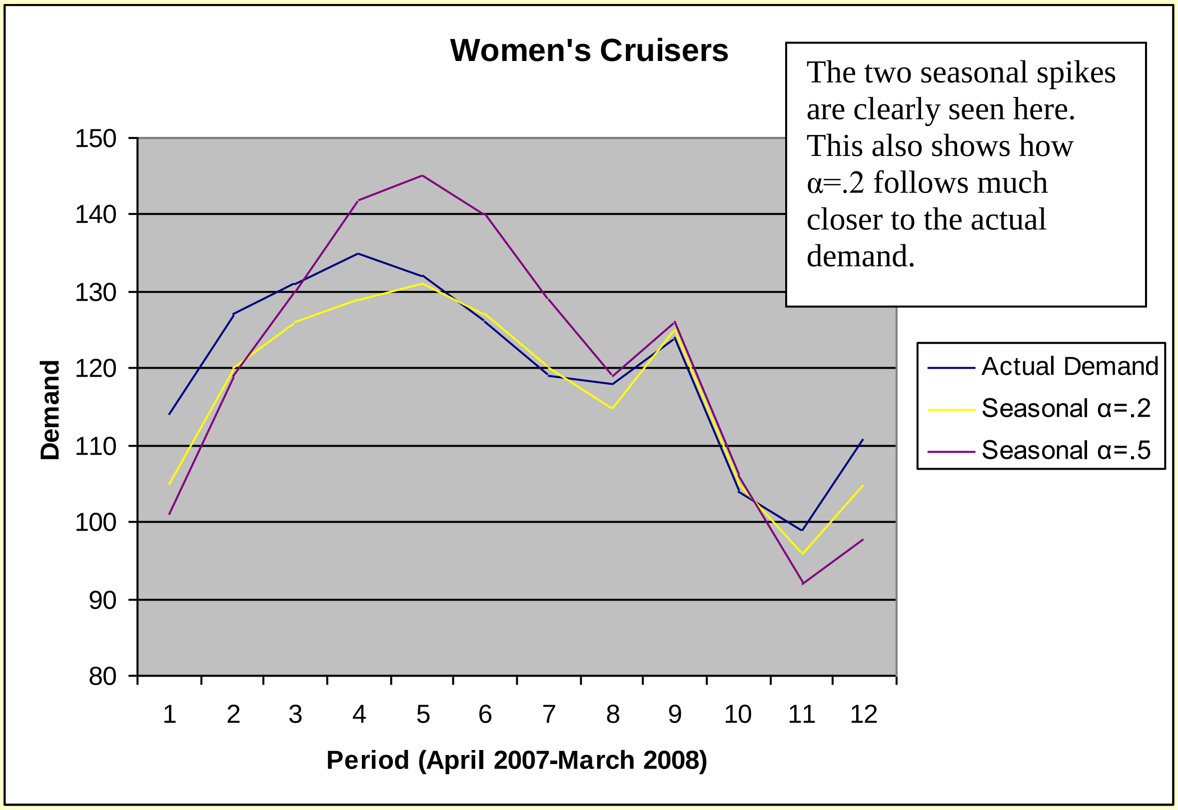
We decided to base our forecast here off of the figures of the seasonal forecast with α=.2 just as we did with the men's cruisers. This measurement yielded a lower MAD and MSE; however, the control chart shows poor results of non-randomness in the form of bias. Although this is troublesome, the range of the errors is not nearly as high as compared to the errors of the seasonal forecast with α=.5.

Women's Forecast Error (Figure 22)



Shows a strong nonrandom bias. The forecast tells us that these errors are underestimating the actual demand during the peak months, which we will have to adjust for by building up our inventory slightly higher than the forecast projects.

Women's Forecast Chart (Figure 23)



The two seasonal spikes are clearly seen here. This also shows how α=.2 follows much closer to the actual demand.

Master Aggregate Plan

Level Production Strategy Aggregate Plan							
Period	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Forecast	475	550	625	650	550	550	3400
Output							
Regular	575	575	575	575	575	575	3450
Overtime	0	0	0	0	0	0	0
Output – Forecast	100	25	-50	-75	25	25	50
Inventory							
Beginning	0	100	125	75	0	25	
Ending	100	125	75	0	25	50	
Average	50	112.5	100	37.5	12.5	37.5	350
Costs							
Output							
Regular	$28,750.00	$28,750.00	$28,750.00	$28,750.00	$28,750.00	$28,750.00	$172,500.00
Overtime	0	0	0	0	0	0	0
Inventory	$500.00	$625.00	$375.00	$0.00	$125.00	$250.00	$1,875.00
Total	$29,250.00	$29,375.00	$29,125.00	$28,750.00	$28,875.00	$29,000.00	$174,375.00

Number of Workers	4
Regular Capacity	640
Overtime Capacity	128
Cost Per Unit	$50.00
OT Cost Per Unit	$65.00
Inventory Cost	$5.00

(Detailed calculations can be found in Appendix B)

Alternative Aggregate Plans

Heavy Overtime Strategy Aggregate Plan							
Period	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Forecast	475	550	625	650	550	550	3400
Output							
Regular	480	480	480	480	480	480	2880
Overtime	95	95	95	95	70	70	0
Output – Forecast	100	25	-50	-75	0	0	-520
Inventory							
Beginning	0	100	125	75	0	0	
Ending	100	125	75	0	0	0	
Average	50	112.5	100	37.5	0	0	300
Costs							
Output							
Regular	$24,000.00	$24,000.00	$24,000.00	$24,000.00	$24,000.00	$24,000.00	$144,000.00
Overtime	$6,175.00	$6,175.00	$6,175.00	$6,175.00	$4,550.00	$4,550.00	$33,800.00
Inventory	$500.00	$625.00	$375.00	$0.00	$0.00	$0.00	$1,500.00
Total	$30,675.00	$30,800.00	$30,550.00	$30,175.00	$28,550.00	$28,550.00	$179,300.00

Number of Workers	3
Regular Capacity	480
Overtime Capacity	96
Cost Per Unit	$50.00
OT Cost Per Unit	$65.00
Inventory Cost	$5.00

Chase Production Strategy Aggregate Plan							
Period	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Forecast	475	550	625	650	550	550	3400
Output							
Regular	500	550	630	630	550	550	3410
Overtime	0	0	0	0	0	0	0
Output – Forecast	25	0	5	-20	0	0	10
Inventory							
Beginning	0	25	25	30	10	10	
Ending	25	25	30	10	10	10	
Average	12.5	25	27.5	20	10	10	105
Costs							
Output							
Regular	$25,000.00	$27,500.00	$31,500.00	$31,500.00	$27,500.00	$27,500.00	$170,500.00
Overtime	0	0	0	0	0	0	0
Inventory	$125.00	$125.00	$150.00	$50.00	$50.00	$50.00	$550.00
Total	$25,125.00	$27,625.00	$31,650.00	$31,550.00	$27,550.00	$27,550.00	$171,050.00

Number of Workers	4
Regular Capacity	640
Overtime Capacity	128
Cost Per Unit	$50.00
OT Cost Per Unit	$65.00
Inventory Cost	$5.00

We have decided to choose a level production strategy not utilizing overtime in order to keep our employees as happy as possible. We develop a close bond to the workers back in the workshop where we craft our bicycles. We have tried our best to keep production levels even throughout the year so they don't get bogged down during the summer time when they would like to be out cruising the beaches themselves. Alternative plans considered hiring only three workers in order to keep costs down, but the amount of overtime generated would create unhappy employees and actually increase costs due to overtime wages.

Material Requirements Planning

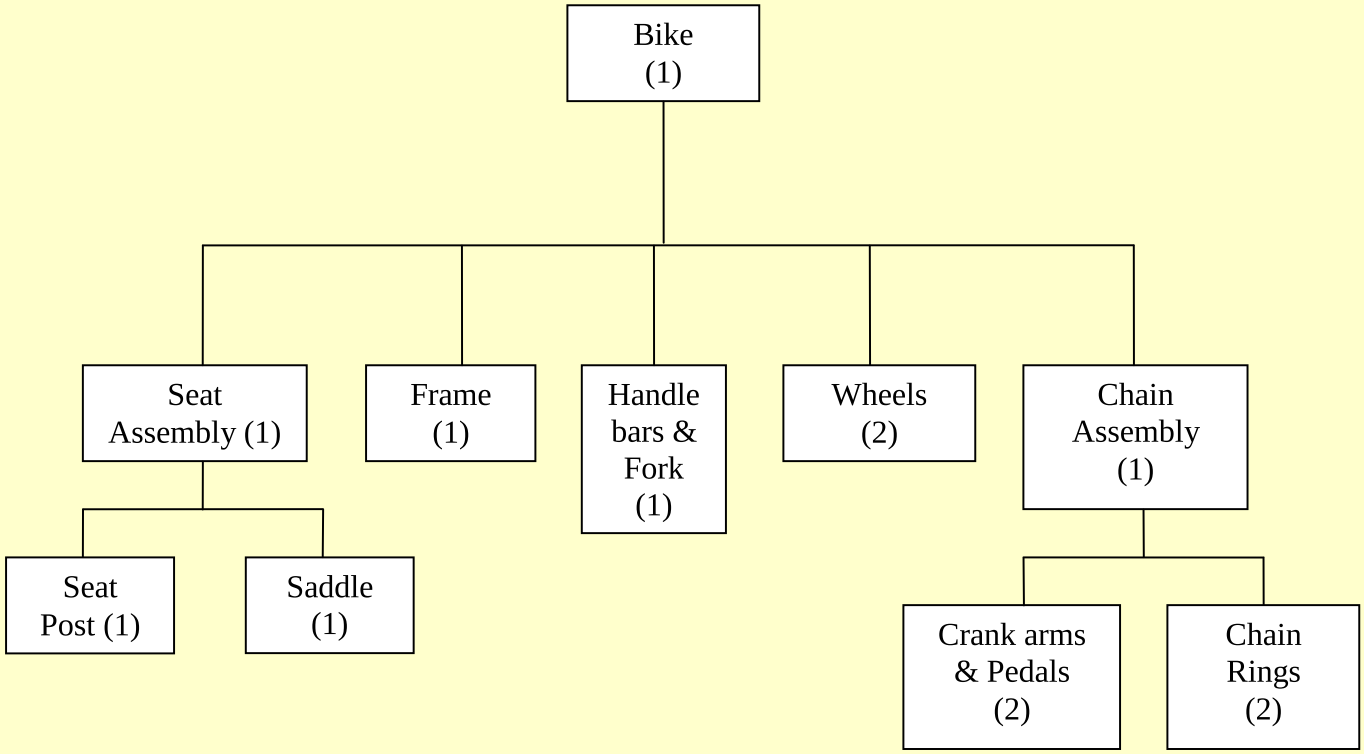
We will maintain integrity of outputs by implementing a regenerative system for updating the MRP periodically, instead of continuously. This regenerative system is well-suited for our simple product and will allow us to keep our costs down as opposed to using a net-change (continuous) system. We will also use lot-for-lot ordering because it is the simplest method for lot sizing and we use our forecasts as a basis for our lot sizes.

Changes to planned orders will most likely be caused by fluctuations of seasonal demand. Since we know the two seasonal increases in demand will be during summer and the Christmas holiday season (from the figures of our forecasts), we will shorten the updating period of our system during these periods of high demand. Updating and revising the plans like this over time will reflect the moving horizon of time.

Another cause of change we expect to encounter is a revision or push-back of due dates during the surge of business in the summer months caused by increased stress on our suppliers. We will keep our production lean but still have enough safety stock on hand for these periods.

Our bikes are made up of 9 essential parts that can be quickly and easily assembled by our staff at the store or by the customer when ordered through our online store. We have shown here the cruiser’s product structure tree and five possible MRP schedules for the men's finished bike, one subassembly, and three sub parts.

CRUISER PRODUCT STRUCTURE TREE (Figure 24)



Inventory Management

At Banzai Beach Cruisers our inventory philosophy is based highly on meeting customer demand. We have “anticipation stocks” of bikes in our shop, held to satisfy the expected demand. When a customer comes through the door (or from the beach), they are supplied with a finished bicycle.

To smooth out our seasonal sales, we build up inventory by producing the same amount of bikes frames monthly, throughout the year, and holding the partially finished bikes until the bicycle season picks up. This keeps our production level even and avoids the hiring / laying off and overtime of our employees. When the bikes are ready to be sold, we add the custom features and paint and show them in our store. Based on previous actual demand of 145-180 men’s bikes per month, we produce 160 bikes a month or 40 per week. The ladies’ bikes actual demand, between 99-135 bikes per month requires us to produce 120 bikes per month, or 30 bikes per week. This keeps our production lean, while utilizing the inventory we have held for months of higher demand. These figures equal the average actual demand per month – men’s 158.5, women’s 120. This “seasonal inventory” reduces the holding cost of inventory, while keeping enough safety stock on hand resulting from preseason production.

For our bike frames we use .035 stainless steel 304 alloy cold-finished, annealed (softened for production, but sturdy), and pickled (oiled for manufacturing –

cutting, welding, etc.), 304 seamless ASTM (American Society of Tubing Manufacturers) A269

This steel provides the stiffness, strength, and weight that our bikes require to remain competitive in the market.

This steel can only be bought in 17' – 24' Random Lengths, which requires us to have enough lead time to submit a Request For Quotation (RFQ) from our suppliers to find an adequate Stock Length for a production run. For example, our Top Tube is 26.62 inches long, adding another 1/8" for cutting space (typical), makes our Top Tube 26.745 inches. If we needed to cut ten pieces, we would need 267.45 inches or 22.2875 feet of steel. We would require *more than* 22 feet, or be left with a piece that was just too short to use and must be considered waste. So we would need, optimally, 23 feet of steel.

Also, since steel has a tolerance level, or adjustment level, of $\pm$.015", we would buy all the steel for a production run, monthly 160 bikes for men and 120 bikes for women, at a single time. The reason we do this is to make sure all the steel is from the same *Mill Production Run*, where it has been produced at the same time and has the same tolerances. This Mill Production Run number is printed on the outside of all tubing. If steel has different tolerances, it may not weld straight, resulting in a break in the frame during riding – which leads to a high liability.

Our welding jigs our designed with this tolerance in mind and can be adjusted ±.015" to assure that each production run will weld together satisfactorily, but the tolerances must be the same for each run. Thus it is important that we use the same Mill Production Run (number) for each of our production runs. That means we order with an adequate lead time in order to secure the optimal Stock Lengths.

Request For Quotation (RFQ):

- Price
- Availability
- Stock Lengths
- FOB Point
- Delivery (usually overnight)
- Payment Terms

For pre-production planning we use:

- Bill of Materials
- Yield List – to determine buy size
- Requisitioning – *Request For Quotation (RFQ)*
- Purchase Approval (by both parties)
- Purchasing
- Costing

We get a price break of:

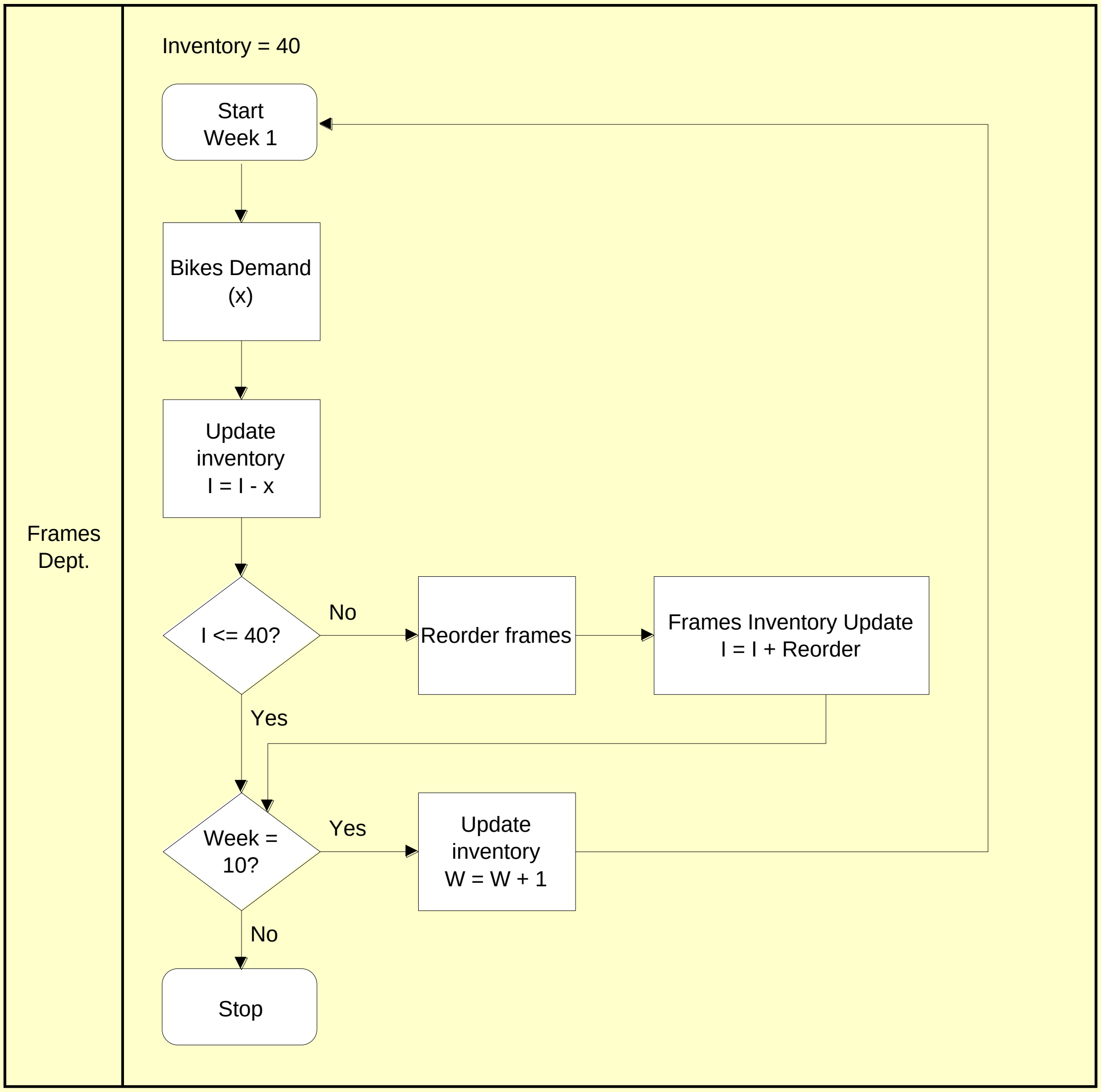
- 2 ½% for 100-500'
- 5% for 500-1000'
- 7% for 1000' + (limit)

We request quotations at the beginning of the month, when our lead time begins. This way we are able to secure the optimal lengths of tubing needed. Calculations can be found in appendix C

Simulation

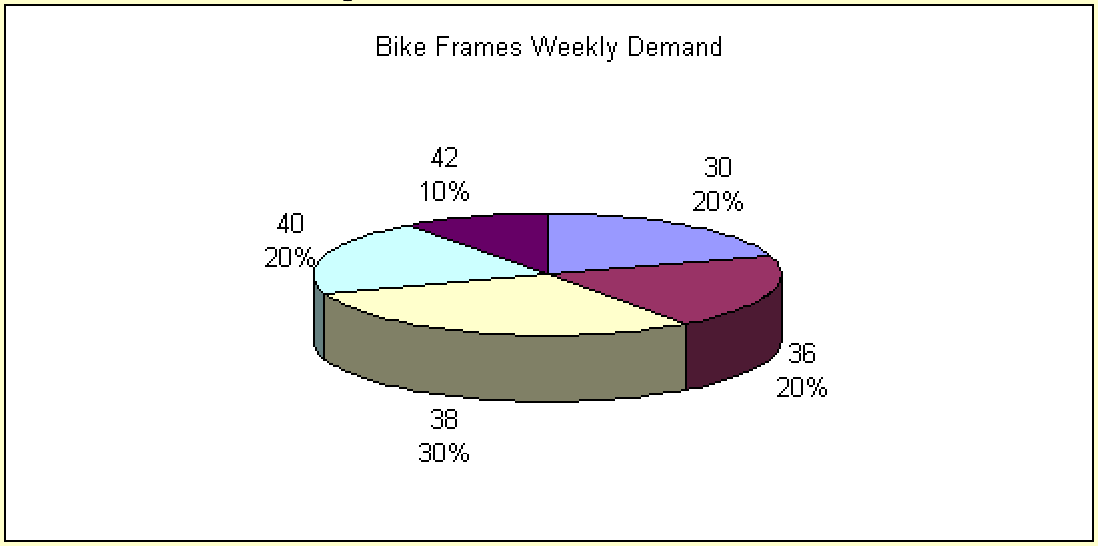
Banzai Bicycles will apply simulation technique for inventory management for bike frames. The project will do a 10-week simulation for ordering bike frames. Bike frames are stored in the inventory and wait for customer orders. When customers place order bikes, bike frames will be ready to put into the assembly line with other bike parts. The inventory will always have 40 frames for each male and female-sized bike. Therefore, when the frames on hand are lower than 40 frames, new production order will be placed.

frames flow.igx (Figure 25)



Bike Frames Weekly Demand	Frequency	Relative Frequency	Cumulative Frequency	Range
30	2	0.20	0.20	01-20
36	2	0.20	0.40	21-40
38	3	0.30	0.70	41-70
40	2	0.20	0.90	71-90
42	1	0.10	1.00	91-100
	10	1.00		

Figure 26



10 Weeks of Demand

Week	Random Number	Demand	Beginning Inventory	Ending Inventory	Lost Sales	Reorder Frames
1	18	30	40	10	0	30
2	25	36	40	4	0	36
3	73	40	40	0	0	40
4	12	30	40	10	0	30
5	54	38	40	2	0	38
6	96	42	40	-2	2	42
7	23	36	40	4	0	36
8	31	36	40	4	0	36
9	45	38	40	2	0	38

10	1	30	40	10	0	30
		356			2	

Average of Demand	35.6	frames/wk
Average of Lost Sales	0.2	frames/wk

Appendix A: Control Chart Measures

Down Tubes

		Sample							
		1	2	3	4	5	Min	Max	Range
Observation	1	700.23	700.11	700.6	699.75	700.55	699.75	700.6	0.85
	2	699.83	700.43	699.92	700.62	699.23	699.23	700.62	1.39
	3	700.225	699.49	701.11	700.83	700.38	699.49	701.11	1.62
	4	699.48	699.93	700.77	699.23	700.41	699.23	700.77	1.54
									1.35

Avg Range	1.35
D3	0
D4	2.28
LCL	0
UCL	3.078

LCL	Center	UCL
0	1.35	3.078
0	1.35	3.078
0	1.35	3.078
0	1.35	3.078

Chain Stay

		Sample							
		1	2	3	4	5	Min	Max	Range
Observation	1	390.72	390.11	390.47	390.09	390.22	390.09	390.72	0.63
	2	390.51	390.01	390.11	390.48	390.13	390.01	390.51	0.5
	3	390.89	390.15	390.22	390.31	390.58	390.15	390.89	0.74
	4	390.07	390.03	390.51	390.27	390.19	390.03	390.51	0.48
									0.5875

Avg Range	0.5875
D3	0

LCL	Center	UCL
0	0.5875	1.3395

			LCL	Center	UCL
D4	2.28		0	0.5875	1.3395
LCL	0		0	0.5875	1.3395
UCL	1.3395		0	0.5875	1.3395

Head Tube

		Sample							
		1	2	3	4	5	Min	Max	Range
Observation	1	160.38	160.23	160.83	160.31	160.11	160.11	160.83	0.72
	2	160.22	160.01	160.11	160.23	160.07	160.01	160.23	0.22
	3	160.77	160.31	160.08	159.84	159.93	159.84	160.77	0.93
	4	160.19	159.87	160.05	160.18	159.79	159.79	160.19	0.4
									0.5675

			LCL	Center	UCL
Avg Range	0.5675				
D3	0		0	0.5675	1.2939
D4	2.28		0	0.5675	1.2939
LCL	0		0	0.5675	1.2939
UCL	1.2939		0	0.5675	1.2939

Seat Stay

Observation	Sample 1	2	3	4	5	Min	Max	Range
1	560.53	560.1	560.22	560.41	560.12	560.1	560.53	0.43
2	560.68	560.32	560.77	560.42	560.81	560.32	560.81	0.49
3	560.77	560.88	560.41	560.9	560.08	560.08	560.9	0.82
4	560.42	560.12	560.31	560.11	560.29	560.11	560.42	0.31
								0.5125

Avg Range	0.5125
D3	0
D4	2.28
LCL	0
UCL	1.1685

LCL	Center	UCL
0	0.5125	1.1685
0	0.5125	1.1685
0	0.5125	1.1685
0	0.5125	1.1685

Seat Tube

Observation	Sample 1	2	3	4	5	Min	Max	Range
1	635.99	635.25	635.11	635.28	635.77	635.11	635.99	0.88
2	635.07	635.89	634.88	635.88	635.55	634.88	635.89	1.01
3	635.11	635.82	635.22	635.53	634.89	634.89	635.82	0.93
4	635.01	635.22	635.69	635.22	635.45	635.01	635.69	0.68
								0.875

Avg Range	0.875

LCL	Center	UCL

D3	0
D4	2.28
LCL	0
UCL	1.995

	r	
0	0.875	1.995
0	0.875	1.995
0	0.875	1.995
0	0.875	1.995

Top Tube

		Sample							
		1	2	3	4	5	Min	Max	Range
Observation	1	600.24	600.33	600.11	599.75	600.41	599.75	600.41	0.66
	2	599.88	600.01	600.55	600.72	600.26	599.88	600.72	0.84
	3	600.04	599.95	600.36	600.02	599.87	599.87	600.36	0.49
	4	600.74	600.44	599.82	600.48	600.12	599.82	600.74	0.92
									0.7275

Avg Range	0.7275
D3	0
D4	2.28
LCL	0
UCL	1.6587

LCL	Center	UCL
0	0.7275	1.6587
0	0.7275	1.6587
0	0.7275	1.6587
0	0.7275	1.6587

Painting

Sample	Defects	LCL	Center	UCL
1	0	0	1.1	4.246427
2	0	0	1.1	4.246427
3	2	0	1.1	4.246427
4	1	0	1.1	4.246427
5	0	0	1.1	4.246427
6	2	0	1.1	4.246427
7	1	0	1.1	4.246427
8	2	0	1.1	4.246427
9	0	0	1.1	4.246427
10	3	0	1.1	4.246427

Average	1.1
UCL	4.246427
LCL	-2.04643

Welding

Sample	Defects	LCL	Center	UCL
1	3	0	1.4	4.949648
2	2	0	1.4	4.949648
3	0	0	1.4	4.949648
4	0	0	1.4	4.949648
5	1	0	1.4	4.949648
6	2	0	1.4	4.949648
7	0	0	1.4	4.949648
8	2	0	1.4	4.949648
9	1	0	1.4	4.949648
10	3	0	1.4	4.949648

Average	1.4
UCL	4.949648
LCL	-2.14965

Appendix B: Material Requirements Planning Calculations

Item:_Bike__, LT:__2_ QPA:____ LS:__30_	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Gross requirements					45	30	50	35	25
Scheduled receipts									
Projected on hand	40	40	40	40	40	25	25	5	0
Net Requirements					5	5	25	30	25
Planned-order receipts					30	30	30	30	30
Planned-order releases			30	30	30	30	30		

Item:_Wheels__, LT:__1__ QPA:____ LS:__50_	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Gross requirements			60	60	60	60	30+60		
Scheduled receipts									
Projected on hand	50	50	50	40	30	20	10	20	20
Net Requirements			10	20	30	40	80		
Planned-order receipts			50	50	50	50	100		
Planned-order releases		50	50	50	50	100			

Item: Chain __Assembly_, LT:_2_ QPA:____ LS:__20_	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Gross requirements			30	30	30	30	30		
Scheduled receipts		20							
Projected on hand	10	30	30	0	10	0	10	0	0
Net Requirements				30	20	30	20		
Planned-order receipts				40	20	40	20		
Planned-order releases		40	20	40	20				

Item: Crank arms & pedals___, LT:__1_ QPA:____ LS:__50_	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Gross requirements		80	40	80	40		60		
Scheduled receipts									
Projected on hand	20	20	40	0	20	30	30	20	20
Net Requirements		60		80	20		30		
Planned-order receipts		100		100	50		50		
Planned-order releases	100		100	50		50			

Item: Chain Rings, LT:__1_ QPA:____ LS:__30_	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
Gross requirements		80	40	30+80	40			20	
Scheduled receipts									
Projected on hand	30	30	10	0	10	0	0	0	10
Net Requirements		50	30	110	30			20	
Planned-order receipts		60	30	120	30			30	
Planned-order releases	60	30	120	30			30		

Appendix C: Inventory Management Calculations

Banzai Beach Cruisers - Inventory Management
Inventory list for Men's Bicycle - using .035 seamless stainless-steel 304 alloy tubing
(adding 1/8" for cutting variance)

Part	Unit Length (In.)	Number of Units	Price per Foot	Optimal Size of Lengths Req'd (Ft.)	Order Price per Length	Number of Lengths Req'd (Rounded Up)	Total Number of Feet	Price of Optimal Order	Quantity Discount (%)	Less: Quantity Discount	Net Order Cost
Top Tube 1 1/4" x .035 (1)	26.745	160	1.75	18	31.50	20	360	630.00			630.00
Down Tube 1 1/4" x .035 (1)	27.725	160	1.75	19	33.25	20	380	665.00			665.00
Seat Tube 1 1/4" x .035 (1)	25.125	160	1.75	21	36.75	16	336	588.00			588.00
Total Tube 1 1/4" x .035							1076	1,883.00	7.0%	131.81	1,751.19
Chain Stays 1" x .035 (2)	15.475	320	1.38	21	28.98	10	210	289.80	2.5%	7.25	282.56
Seat Stays 5/8" x .035 (2)	22.165	320	0.85	19	16.15	16	304	258.40	2.5%	6.46	251.94
Head Tube 1/2" x .035 (1)	6.425	160	0.67	22	14.74	4	88	58.96	0.0%	0.00	58.96
Total Order for 160 Bikes								2,490.16		145.52	2,344.65

Optimal Order Men's **Tube Length**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Top Tube	7.628	8.076	8.525	8.974	9.422	9.871	10.320	10.768
Down Tube (Men's - 1)	7.358	7.791	8.224	8.656	9.089	9.522	9.955	10.388
Seat Tube	8.119	8.597	9.075	9.552	10.030	10.507	10.985	11.463
Chain Stays	13.183	13.958	14.733	15.509	16.284	17.060	17.835	18.611
Seat Stays	9.204	9.745	10.286	10.828	11.369	11.911	12.452	12.993
Head Tube	31.751	33.619	35.486	37.354	39.222	41.089	42.957	44.825

# of lengths for 160 parts	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Top Tube	22.857	20.000	20.000	20.000	17.778	17.778	16.000	16.000
Down Tube (Men's - 1)	22.857	22.857	20.000	20.000	17.778	17.778	17.778	16.000
Seat Tube	20.000	20.000	17.778	17.778	16.000	16.000	16.000	14.545
Chain Stays	12.308	12.308	11.429	10.667	10.000	9.412	9.412	8.889
Seat Stays	17.778	17.778	16.000	16.000	14.545	14.545	13.333	13.333
Head Tube	5.161	4.848	4.571	4.324	4.103	3.902	3.810	3.636

Part	Unit Length (In.)	Number of Units	Price per Foot	Optimal Size of Lengths Req'd (Ft.)	Order Price per Length	Number of Lengths Req'd (Rounded Up)	Total Number of Feet	Price of Optimal Order	Quantity Discount (%)	Less: Quantity Discount	Net Order Cost
Top Tube 1 1/4" x .035 (1)	26.745	120	1.75	20	35.00	15	300	525.00			525.00
Down Tube 1 1/4" x .035 (2)	27.725	240	1.75	20	35.00	30	600	1,050.00			1,050.00
Total Tube 1 1/4" x .035							900	1,575.00	5.0%	78.75	1,496.25
Chain Stays 1" x .035 (2)	15.475	240	1.38	22	30.36	12	264	364.32	2.5%	9.11	364.30
Seat Stays 5/8" x .035 (2)	22.165	240	0.85	20	17.00	8	160	136.00	2.5%	3.40	135.98
Head Tube 1/2" x .035 (1)	6.425	120	0.67	24	16.08	10	240	160.80	2.5%	4.02	160.78
Total Order for 120 Bikes								3,811.12		95.28	2,157.30

Optimal Order Women's **Tube Length**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Down Tube (Women's - 2)	3.679	3.895	4.112	4.328	4.545	4.761	4.977	5.194

# of lengths for 160 parts	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Top Tube	17.14285714	15	15	15	13.33333333	13.33333333	12	12
Down Tube (Women's - 2)	40	40	30	30	30	30	30	24
Seat Tube	15	15	13.33333333	13.33333333	12	12	12	10.90909091
Chain Stays	9.230769231	9.230769231	8.571428571	8	7.5	7.058823529	7.058823529	6.666666667
Seat Stays	13.33333333	13.33333333	12	12	10.90909091	10.90909091	10	10
Head Tube	3.870967742	3.636363636	3.428571429	3.243243243	3.076923077	2.926829268	2.857142857	2.727272727

Annual Demand	
Men's	1902
Women's	1440

Holding costs	
Men's ($125.00 X 25%)	31.25
Women's ($100.00 X 25%)	25.00

Holding costs and unit price are for frames only

Annual Set-up Cost	
Men's ($50.00 X 12 months)	600.00
Women's ($50.00 X 12 months)	600.00

Economic Order Qty. (EOQ)	Annual Demand	Annual Set-up Cost	Annual Holding Cost	Optimal Order Quantity
Men's Bicycle Frames	1,902	600.00	31.25	270
Women's Bicycle Frames	1,440	600.00	25.00	263

Purchase Cost.

Men's	Total Cost	Quantity Discount (%)	Less: Quantity Discount	Purchase Cost (Lot)	Purchase Cost per Unit
Tube 1 1/4" X .035	1,883.00	7.0%	131.81	1,751.19	10.94
Tube 1" x .035	289.80	2.5%	7.25	282.56	1.77
Tube 5/8" x .035	258.40	2.5%	6.46	251.94	1.57
Tube 1/2" x .035	58.96	0.0%	0.00	58.96	0.37
Total Cost per Unit					14.65

Women's	Total Cost	Quantity Discount (%)	Less: Quantity Discount	Purchase Cost (Lot)	Purchase Cost per Unit
Tube 1 1/4" X .035	1,575.00	5.0%	78.75	1,496.25	12.47
Tube 1" x .035	364.32	2.5%	9.11	364.30	3.04
Tube 5/8" x .035	136.00	2.5%	3.40	135.98	1.13
Tube 1/2" x .035	160.80	2.5%	4.02	160.78	1.34
Total Cost per Unit					17.98

Total Cost Equation	Carrying Cost (Q/2)*H	Order Cost (D/Qopt)*S	Purchase Cost PD	Total Cost
Men's	2,500.00	4,222.71	27,871.97	34,594.67
Women's	1,500.00	3,286.34	25,887.54	30,673.88

Re-Order Point d x LT (Months)	Demand	Lead Time (Months)	Re-Order Point
Men's	158.5	1	158.5
Women's	120	1	120

Both demand and lead-time are constant