How Baseballs are Made

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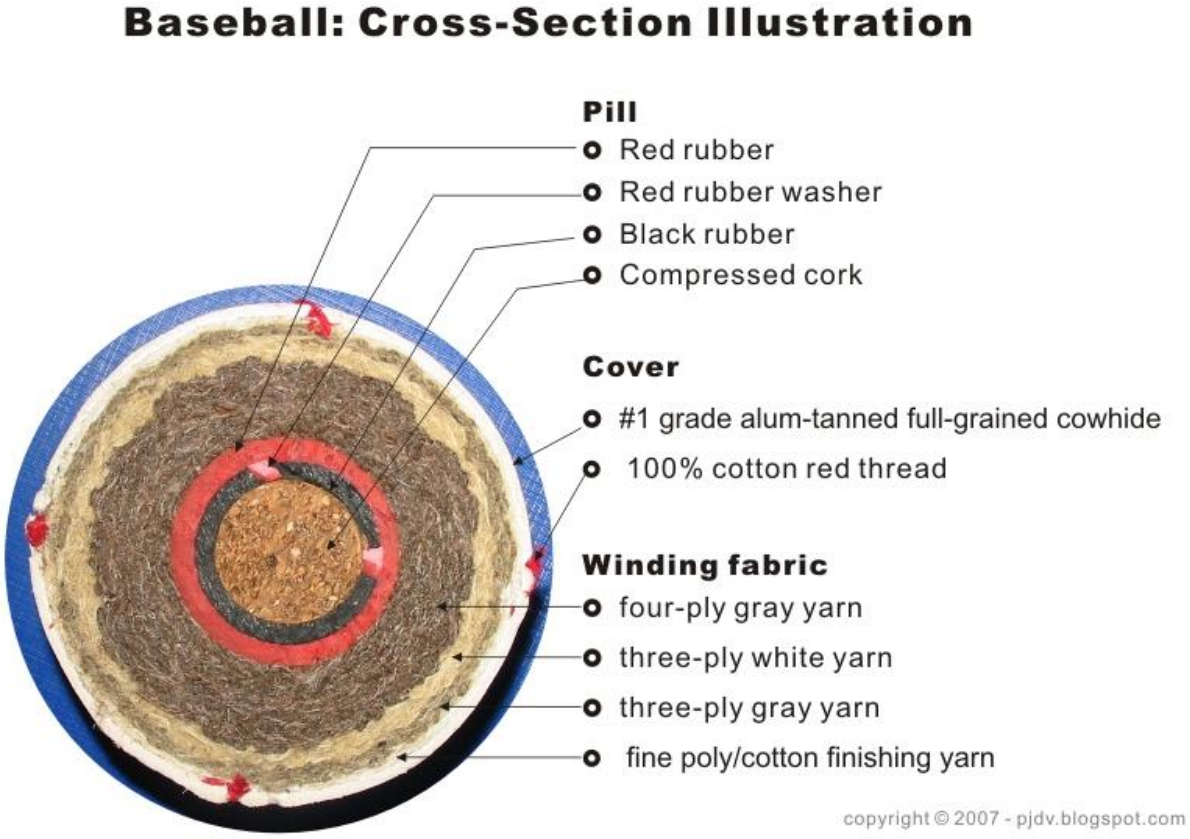
MEEG 453

Self-Selected Homework 1 -11/15/18



Summary – America's favorite pastime of baseball has a ball that is much more complicated than meets the eye. An overview of the manufacturing process for a baseball is provided below along with the technical details and testing required in order to produce a baseball.

Manufacturing a Baseball

The manufacturing process for making a baseball is much more complex than one might think when looking at a baseball from the outside, but each baseball that is made has many steps to reach the finished product. The first step in this process would be manufacturing what is known as the "pill" of the baseball. The pill consists of three layers, the first of these being the cork center. The cork is wrapped in two hemispherical halves that are molded and then sealed around the cork with a red rubber gasket to keep the black rubber in place. Next a layer of red rubber is molded onto the outside of the rubber encasement. These three layers form the "pill" of the baseball. From here the "pills" are placed into a rotating drum with an adhesive substance. The rotating drum is used to ensure that the adhesive is evenly spread on the entirety of the "pill".

Baseball "pills"

Baseball "pills" with adhesive in rotating drum

The adhesive on the pill is necessary in order to move onto the next step which is fabric winding. There are four different layers of fabric that are wound around the pill. The first of these layers of fabric is a four-ply gray wool yarn that is wound using a computerized winding machine that allows the yarn to maintain a constant tension while being wound. The winding machine also allows the ball to be wound very consistently that allows the ball to have a uniform surface. The second of these layers consists of a three ply white yarn that is also wound around the ball in the exact same way as the gray yarn. Finally, a third layer of three ply gray yarn is wound around the ball, again using the computerized machine winding technique. Then a layer of fine finishing yarn that is a combination of polyester and cotton is wrapped around the ball. This layer is necessary in order to hold in place and protect the wool yarn below.

4-ply gray wool

3-ply white wool

3-ply gray wool

Poly/Cotton yarn

These layers of yarn are necessary for the baseball to be able to maintain its overall shape after repeated impacts from a baseball bat. After this winding the ball is trimmed of any and all excess material. This ball is referred to as the “center” Then the “centers” are taken together and placed in a rotating drum with an adhesive mixture. This process is the same as it was for the “pills”. The “centers” are placed in the rotating drum in order to allow an even coverage of adhesive to the entirety of the ball.

“Centers” in rotating drum with adhesive

The cowhide covering for the “center” comes next. The cowhide cover is cut in a figure eight shape using a hydraulic press and dies. The figure eight pattern that is cut out also includes the cut outs for all of the holes close to the edge of the figure eight shape that will allow the cowhide to be stitched together easily. Once the cowhide is cut out they also receive a coating of the adhesive. Then one “center” has two cowhide coverings placed on the “center that cover the entirety of the “center” and fit perfectly to the “center”.

Worker using hydraulic press to cut out the cowhide coverings

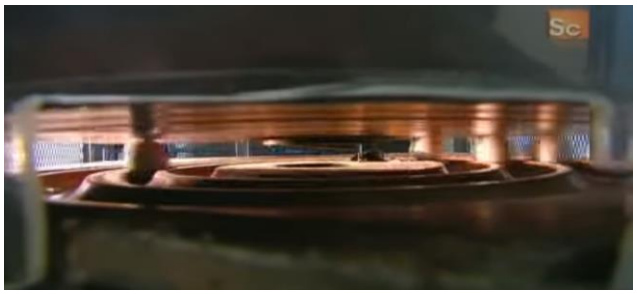
Die and completed cowhide covering

The ball is then placed into a clamp and the two cowhide coverings are sewn together using two needles and waxed red thread. The coverings are cross stitched together, and the first and last stiches are hidden by feeding the thread back through the ball and trimming it very tightly. The stiches are then pulled into a V configuration that gives the baseball its classic look and feel.

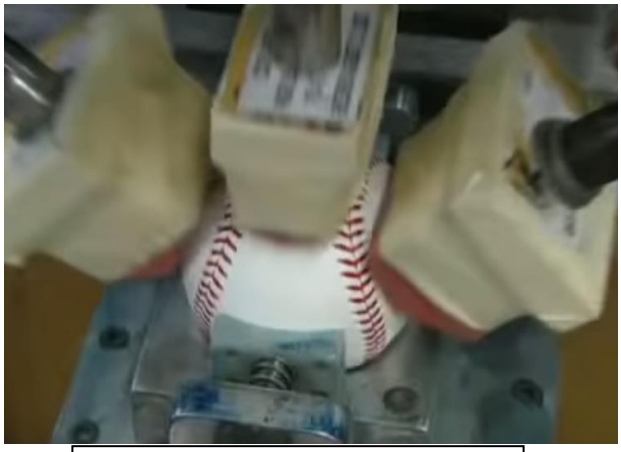
Ball at the first stitch in the process

Ball at the last stitch in the process

The baseballs are then fed into a press machine for 15 seconds that smooths down the seams on the ball. The baseball is then placed into a three headed stamper that places the trademark, league logo, and commissioner's signature onto each and every ball. With drying times for the adhesives this process takes about one week from start to finish for a completed product.



Press used to smooth out the seams on the ball



Three headed stamper add the finishing touches

Technical Aspects of a Baseball (Quality Control)

The baseball making process is one that involves many precise measurements and involves a good amount of quality control before the baseballs are sent out to the customers. The baseball starts with the a cork sphere of 2.06 cm in diameter, then two the two hemispheres, .39 cm thick, are added to the cork. This is followed by the layer of red rubber that is .24 cm thick that covers the black rubber. This gives the “pill” which is approximately 10.48 cm in circumference. Then the first layer of wool is added with 110.6 meters of 4 ply gray yarn. After that comes the 41.43 meters of 3 ply white yarn. This is followed by 48.44 meters of 3 ply gray yarn. Finally the 137.1 meters of finishing yarn is wrapped around the ball. Once the cowhide coverings are placed over the ball there is 223.52 cm of waxed thread used to make the 108 stitches in the sewing process of the baseball.

After the baseball is completed there is acceptance sampling used to test a portion of the balls to make sure they are acceptable for use. The baseballs are tested in order to measure their Coefficient of Restitution, using a process that is officially sanctioned by the MLB. These tests are preformed to ensure the resiliency of the baseball. The first test is to fire the baseball out of an air cannon at 85 feet per second at a wooden wall 8 feet away from the cannon. To pass this test the baseball must rebound from the wall at 54.6 percent of the initial velocity, plus or minus 3.2 percent. This means that the rebound speed must be between 49.13 feet per second and 43.69 feet per second in order to move onto the next test. The next test for the baseball is to retain its shape. This is tested by compressing the baseball between two rigid surfaces 200 times with a 65 pound force each time. In order to pass this test the baseball must be distorted no more than .08 inches from its original shape. If the baseball passes both of these tests then it is acceptable for use and the batch can be sent out to consumers.

Relevance for Beginning and Experienced Engineer

For the beginning engineer it is important to remember that even though a product may look fairly simple on the outside or at first glance that many product require a multitudes of steps to make and manufacture the finished product. In something as simple as a baseball there are at least 8 different layers and steps to add each of these layers to the ball. It is extremely important to be aware of this because the material for all of the different layers has to come from somewhere, whether that may be in-house or outsourced. The decision of where to get these materials from can greatly affect the quantity, quality, and cost of the product you are making, which will ultimately determine if your product will be successful.

For the experienced engineer it is important to remember that the human worker is just as important in the manufacturing process as the automated or robotic worker. It is also important to realize where the automation is necessary and useful for process improvement in order to ensure that your process doesn't become over-automated to the point where it hurts your manufacturing ability in the end. Being aware of this will help the experienced engineer to ensure that the manufacturing process is as efficient as possible.

Learning

Through the work that I have done I learned that making a baseball take a lot more effort than I originally thought. I had originally assumed that a baseball was just a rubber ball that was then covered to give it its final look. Then I learned that a baseball actually consists of many layers of yarn and rubber with cork at the center. Through this process I realized that the process of manufacturing a baseball is fairly complex and has many important steps that must be followed in order for the ball to be acceptable. From this realization I was able to learn just how many steps and components are actually necessary to make a baseball.

References

How Products are Made- Baseball

http://www.madehow.com/Volume-1/Baseball.html

Design Life-Cycle – Baseball

http://www.designlife-cycle.com/baseball/

How It's Made – Baseball

https://www.youtube.com/watch?v=sXS9dfzUbxw

1. **Processes for Discrete Parts:** Mfg. Basics, Materials, Castings, Plastic Molding & Shaping, Composites, Forming, Machining, Joining & Assembly (at least one observation on Joining or Assembly), Surfaces, Mat'l Handling-Unit Loads (at least one observation on Materials Handling-Unit Loads), Process Selection
    a. Castings- Castings from the forge in New Jersey come in with some contaminants on them like rust and other imperfections, so the castings are cleaning in a bath that uses electricity to clean off the parts.
    b. Joining & Assembly- three part pipe fittings are assembled by hand after the pieces are made by the machines
    c. Materials Handling- Parts all have barcodes associated with them that are used throughout the entire machining process from stock selection to finished part.
    d. Machining- Machine centers are used to make various different pipe fittings
    e. Machining- Cylindrical stock is cut down using a bandsaw that operates similar to a meat slicer that is able to produce repetitively precise cuts about every 20 seconds
2. Cite 4 observations noting source (which video) on Part 2 **"Technology"** topics: Quality Concepts, Quality Methods/SPC, Machine Vision, Inspection, Metrology, Automation, Numerical & Auto Controls, Ergonomics (at least one observation on Ergonomics), Industrial Robots
    a. Ergonomics- In the packaging area chairs were adjustable along with work surface in order to keep work surface at a neutral angle.
    b. Industrial Robots- Both "friendly" and "non-friendly" robot were in place the " friendly" robots would stop operating if contacted, where the " non-friendly" robots were caged due to the fact that they operated in the same path regardless of people or other objects being in the way.
    c. Machine vision- Many of the robots photographed the part before doing anything with it in order to tell the robot how to pick up said parts.
    d. Quality Methods- Go/No-Go gauges were seen being used on many different parts as we toured the facility.
3. Cite 4 observations noting source on Part 3 & 4 **"Continuous Processes Systems & Industries,"** & **"Current Advances,"** topics: Mat'l Handling-Bulk Solids, Packaging, Web Processes & Web Handling, Microelectronics, Automotive, other industries, Just-In-Time, Lean Mfg., Simulation, Maintenance & Reliability, Computer Integrated Mfg (CAD/CAM), Safety, Sustainable Mfg. (Waste-Environment)
    a. Packaging- All of the labelling of the packages were done in an automated process whereas the packages were mainly packaged by hand.
    b. Computer Integrated Mfg (CAD/CAM)- CAD/CAM processes were used in most of the machines in the facility like their machine centers.
    c. Safety- All workers were wearing proper PPE and all machines had the potentially dangerous parts behind either a guard or a cage to ensure worker safety
    d. Sustainable Mfg. (Waste-Environment)- All chips that are produced are drained of the cutting fluid, the cutting fluid is then reused and the dry chips are sent away to be recycled/reused.
4. The fitting was made of three separate parts that were all made in separate areas. The three different parts were then placed by the worker who put all of the components together to make the finished product. There was human assembly used to put the part together. One issue with this was that there was only one worker assembling these fittings, so there was not really any potential for an extremely high quantity of fittings to be produced. However the worker assembling these fittings could easily detect if there were any issues in the part as he was assembling.
5. In the packaging/inspection area of Penn Machine they had adjustable computers for some of the machines. This is designed for most people in the 5% female to the 95% male range and it allows the worker to use the computer at a neutral angle. This will allow workers to be more productive because they can move the screen to a height where they can effectively use it and it will extend the overall life of the worker since they don't have to go to any weird angle to do their job.
6. I noticed that the material handling of their unit loads all had pallets under the unit load. This allows for the unit loads to be easily moved by the forklifts of pallet jacks that they had at Pann Machine. The use of pallet allows for ease of movement of their unit loads. The pallets are also reusable which makes this process inherently environmentally friendly.
7. Penn Machine had bins next to all of their automated machining centers that the chips were fed into from the machines, these chips are drained of all cutting fluid. The cutting fluid is then reused in the machine. The chips are then used to fill large barrels. Once the barrels are full they are sent to be recycled/recused. This is an environmentally and economically sound practice because they are able to save money on cutting

fluid by reusing it and reducing the need for large quantities of cutting fluid to be made. They are also getting a return for the chips, something that is completely useless to them that they can send somewhere and make money off of it instead of paying someone to take the chips to the dump.