ME 476C: Senior Design

Northern Arizona University

Srinivas Kosaraju

Nestle Purina – Dryer Efficiency

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Team 2:

Andenmatten, Daniel

Hoffman, Brandon

Kish, Nathan

Simpson, Chris

Wu, Pengfei

Nestle Purina is one of the top manufactures of pet food in the United States, with the Flagstaff, AZ plant producing about 1,000 tons of pet food each day. When the food is done cooking it contains a 35% moisture content. Therefore all of the food produced needs to be properly dried to meet the 11.5% moisture content requirement. This requirement was set forth to reduce the risk of mold growth due to the build-up of condensation in the bags while cooling. To dry the food, the Flagstaff plant has five steam powered dryers, each responsible for about 20%. However, dryer three is not running as efficient as the other dryers. This dryer should be capable of producing 200 tons per day, but has recently been producing only 150 tons per day, while still using the same amount of energy as the other 4 dryers. The lack of productivity is largely due to the condensation in the steam used for drying the pet food. Because of the large scale of production, this degree of inefficiency costs our client a large amount of money in terms of unmade product. By looking into the heat transfer and thermodynamic properties of this system, we hope to increase the efficiency, throughput, and value of dryer 3 for Nestle Purina.

After the discussion of the problem with our client, we broke the overall problem into four categories: goal of the project, objectives, constraints, and the test environment. Our goal is to increase the dryer efficiency in dryer three, which has had substantial efficiency and throughput issues when compared to other three steam operated dryers. In order to accomplish this, we must come up with an inexpensive solution to increase the dryer efficiency. The overall objectives of the project are shown in Table 1. Overall, we were given three constrains we absolutely had to meet during the project. The first constraint is that the moisture content must be less than 11.5% to avoid the growth of mold in the product. The second constraint is that the payback period should be less than eight years to justify the cost of the project. The last constraint is there must be no condensation in the steam coils so heat transfer can occur optimally. After we implement the changes to the dryer, we can test how it functions at the Nestle Purina plant in Flagstaff, AZ as well as in a computer modeling system.

Table 1: Objectives and how they are measured

Objectives	Basis for Measurement	Units
Inexpensive	Implementation costs	$
Production output	Weight of product	Tons
Moisture content	Amount of water	%
Efficiency	Energy used	Btu/ton
Condensation	Weight of water in the steam	Kg water/ kg steam

In order to better understand some considerations we needed to follow when designing the dryer, with the help of the client, we created some criteria to follow (Figure 1). The criteria was split into three different categories: costs, moisture control, and production. The most important criteria to consider with the designs of the dryer are the amount of money that will be spent. The total cost includes the payback period which is the amount of time that it takes for the money spent to pay for itself. The next category is moisture control. This category was then split into the amount of water that is still in the product, and the amount of condensation that is in the steam. The final category is the total production of the dryer. This includes the total amount of product that can be pushed through the dryer in a span of an hour and how much power we need to push that much product through. We also need to compare the new efficiency of the dryer to the efficiency of the old dryers.

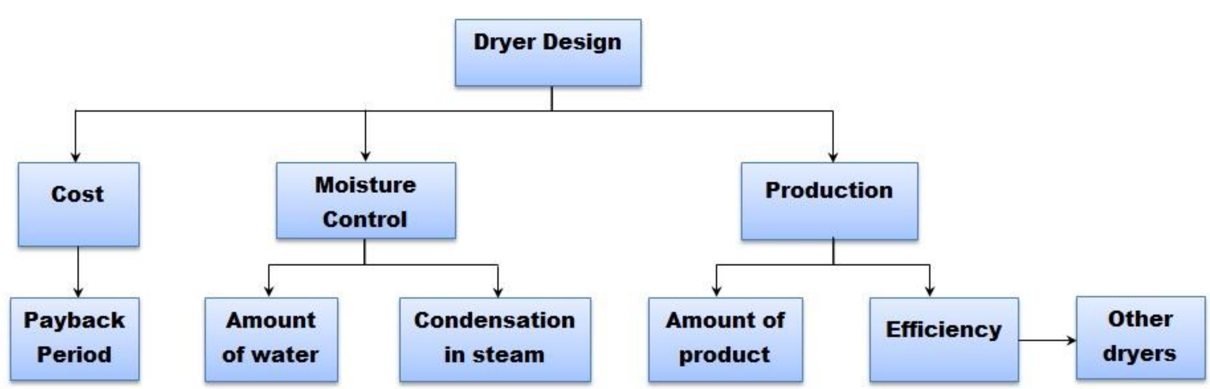


Figure 1: Criteria Tree

The dryer runs on steam in conjunction with an air circulation system (Figure 2). The plant produces its own steam in a natural gas boiler. This steam is then pumped at approximately 100 psi to the dryer unit. In the dryer, steam is continually pumped through steam coils. The air circulation system blows air over the steam coils to heat the air to around 280 degrees Fahrenheit. Hot air has a larger capacity to remove moisture than air at a lower temperature. This air passes through the moist product and removes moisture from it. After this, the air is re-heated and passed through the product twice more. After these three drying sections, the product enters the fourth and final section of the dryer. In this section, the product is cooled to about 100 degrees Fahrenheit before it is sent to further processing.

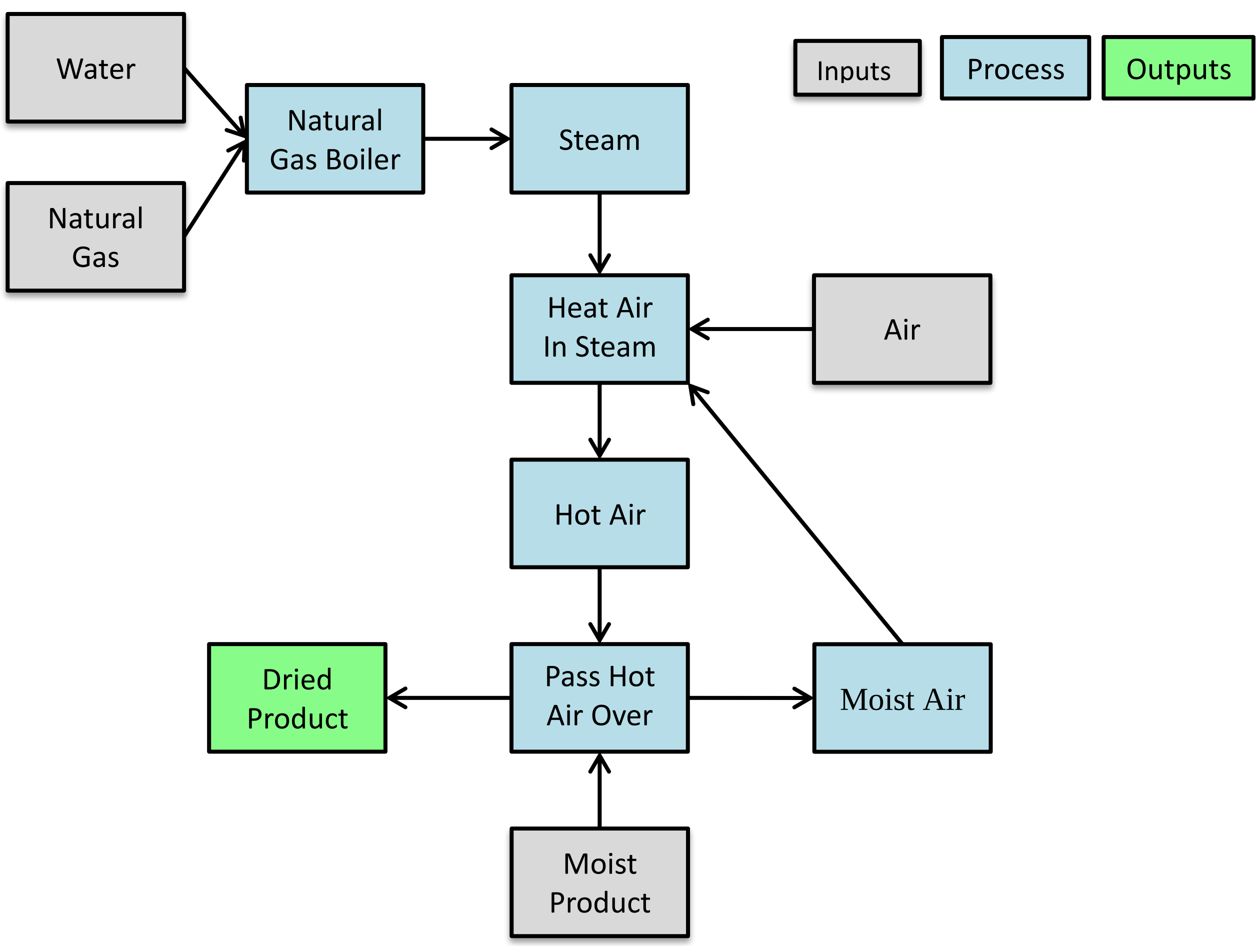
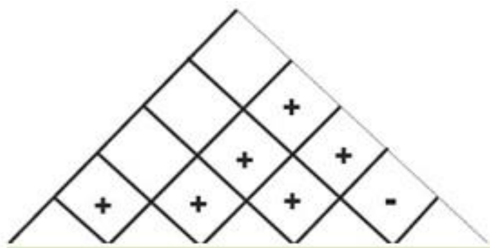


Figure 2: Functional Diagram of the dryer

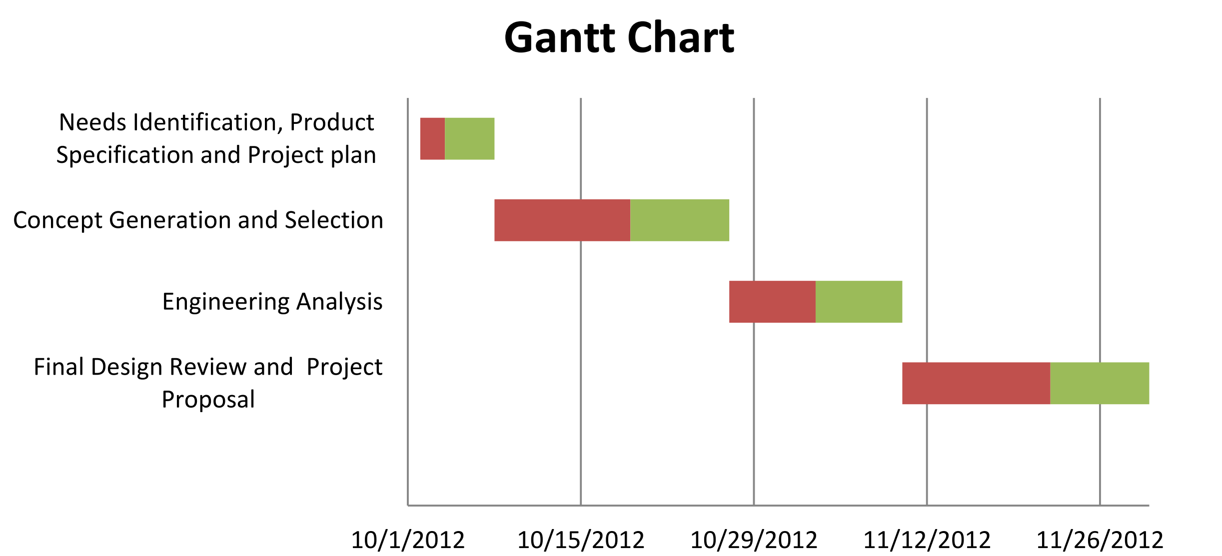
A quality function deployment table compares customer needs to engineering needs. It relates overall design to reasonable engineering specifications. As you can see in Figure 3, cost relates to all of the customer requirements. To make the dryer more efficient for allowing more product throughput, the cost will increase. To be more durable, there will be more materials used or longer lasting parts which will be more expensive. This also affects the overall weight of the dryer and energy reduction. Ideally, the output should be 10% more efficient than the dryers already in use which gives us the engineering targets. The house of quality refers to how the engineering requirements relate to each other. There is a positive correlation (+) between cost and energy reduction. This means that by increasing the cost, the energy reduction should be larger. By increasing the energy reduction, the output tonnage decreases. This is a negative correlation (-).



		Engineering Requirements				
		Weight	Cost	Payback Period	Energy reduction	Tonnage
Customer Requirements	Inexpensive	x	x	x	x	
	Allow for more product throughput		x	x	x	x
	Durable	x	x	x		
	Units	ton	$	yrs	%	ton
		100	250k	8	10	20/day
		Engineering Targets				

Figure 3: Engineering Requirements vs. Customer Requirements with a correlation tree

To make sure the project is on the right track, four sections were created; needs identification, product specification and project planning, concept generation and selection, engineering analysis, and final design review and project proposal. Both a presentation and a report are required for each of these sections. The presentation preparations begin as soon as the prior report is submitted. Each report is due the Friday after the corresponding presentation. The composing of the report starts once the outline for the presentation has been established, about half way through the presentation preparations. The dates of the presentations are at the transition from red to green. Figure 4 shows the breakdown of the proposed schedule for the fall semester. This includes the dates of the presentations and the amount of days that we allocated for each section.



		Final Design Review and Project Proposal	Engineering Analysis	Concept Generation and Selection	Needs Identification, Product Specification and Project plan
Date		11/10/2012	10/27/2012	10/8/2012	10/2/2012
Presentation (Days)		12	7	11	2
Report (Days)		8	7	8	4

Figure 4: The proposed schedule for each of the 4 sections.

Using the design process laid out in this report, we hope that our efforts in the redesigning of dryer 3 will meet the customer's expectations.