Apollo Paper Company

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Introduction

Apollo Corporation is a paper manufacturer that sells medium-quality paper in a variety of sizes. In early 1992, Apollo decided to develop a high-quality paper, named *Elite*, to round out its product line. With a late 1992 introduction planned for *Elite*, Apollo's operations division had only eight months to set up the paper's manufacturing process. Because of tight schedule constraints, the optimization of the processes was relegated to a later time.

The *Elite* paper was heavier, glossier, and whiter that the medium-quality papers available on the market. Because they predicted limited demand for *Elite*, Apollo decided to price it only slightly higher than their medium quality paper. However, *Elite's* material and production costs were significantly greater than those of its medium-quality paper.

Demand for *Elite*

The demand for *Elite* Paper turned out to be much greater than anticipated. Customers liked *Elite's* heavier feel, glossiness, whiteness. They found it to be an especially good value for the price. Although Apollo was extremely pleased with *Elite's* initial success, *Elite's* profit margin was too low to justify its production in the long term. One way or another they had to improve their margins on *Elite*. Instead of risking customer loss as a result of raising *Elite's* price, Apollo chose to focus on reducing the production costs.

Production

Poster paper is manufactured in a continuous process. Rolls of dry paper feed stock are pulled through a series of machines to emerge as finished poster paper. The feedstock is characterized by its dry weight (bone dry weight in pounds per thousand square feet (KSF)) and caliper (thickness in mils). The paper is first treated with titanium dioxide (TiO2), a whitening agent, and then coated. The coating, a polyethylene resin which also contains TiO2, is applied to both the wire (bottom) side and face (top) side of the paper in polyethylene extruder machines. The speed of the process is limited by the thickness of the applied resins. (Increasing resin thickness decreases the process speed.)

face side polyethylene

paper

wire side polyethylene

Poster Paper Cross Section
(not to scale)

The increased production costs stemmed from the increased polyethylene laydown required on *Elite*. The paper coating operation increased the polyethylene laydown on the face side from six pounds per thousand square feet to thirteen pounds per thousand square feet and increased the wire side laydown from six pounds per thousand square feet to eleven pounds per thousand square feet (#/KSF). In addition to the higher material costs, the large increase in polyethylene laydown caused serious processing problems. It was causing machine rolls to fail and was forcing Apollo to reduce the machine speeds from 700 feet per minute to 400 feet per minute (fpm). This posed a serious problem as the facility was loaded to 95% capacity. The purchase of further capacity would be extremely costly. Speeds of less than 600 fpm would be unprofitable. The production engineers hoped to increased the speed to the maximum of 1000 fpm.

Over the past two years the Apollo process engineers, after conducting rigorous statistically designed experiments, had compiled detailed sets of equations describing various facets of the paper product (see Exhibit 1).

In December 1994, a joint meeting between marketing and production was held in an attempt to find a way to alter the process so that the product could be profitable at the current price.

Marketing brought information about customer expectations. This information had been gathered from focus groups, surveys and general market research. The feature of *Elite* paper that customers most liked was its stiffness. The process parameter that affected stiffness was termed sensitized stiffness. It needed to be in the range of 315 - 350. Marketing also found that customers could not determine a difference in gloss levels ranging from 40.5 to 63 and that A_{TT}, a measure of overall attractiveness, could range between 93.75 and 94.00.

The production people believed that a reduction in face side resin coverage from 13#/KSF to 9#/KSF would allow the machines to run at 600 feet per minute (fpm). Resin coverage of less than 6#/KSF would be inadequate. Feedstock was available in weights ranging from 30 - 40#/KSF and at calipers between 6.00 - 7.30 mils. The resulting density needed to fall in the range of 0.98 - 1.10. The amount of TiO2 in the paper traditionally ranged between 0 - 5% and in the resin between 8 - 12.5%. To achieve the desired sensitized stiffness values it was believed that an intermediate process variable (termed B-319 stiffness) needed to be in the range of 120 - 250 and the sensitized caliper (a measure of caliper adjusted to account for the wire and face side coatings) between 8 - 13 mils.

Curl, which was determined by the difference in face side and wire side coatings had to be between 0 and 1 to satisfy both production and customer requirements

EXHIBIT 1

Variables	Units
Dry Weight	#/KSF
Caliper	mils
Sensitized Caliper	mils
Wire Side (resin coverage)	#/KSF
Face Side (resin coverage)	#/KSF
TiO2 Paper	percentage points
TiO2 Resin	percentage points
Process Speed	fpm
Cost	$/KSF

All other variables are dimension-less.

Process equations:

Density	0.1922 * (Dry Weight/Caliper)
Sensitized Caliper	0.176 * (Wire Side + Face Side) + Caliper + 0.44
A_{TT} Color	-0.774 + (0.165*TiO2 Paper) + (0.026*TiO2 Resin)
A_{TT} Physical	-0.8527 + (-2.6*Density) + (0.104* Dry Weight)
B-319 Stiffness	-404.7 + (67.1* Caliper) + (139.4* Density)
Sensitized Stiffness	-188 + (0.865*B-319 Stiffness) + (30* Sensitized Caliper)
Process Speed	1050 - (50* Face Side)
Curl	Wire Side - Face Side
Gloss	-9.958 + (5.625* Face Side)
A_{TT} total	93.567 + (0.5* A_{TT} Physical) + A_{TT} Color

COST:
(0.363*Wire Side) + (0.752*Face Side) + (0.41581*Dry Weight) +
(1.09)*(TiO2 Paper/100)*(Dry Weight) + (0.3597)*(Face Side)*(TiO2 Resin/100)

After reading the case you should examine the spreadsheet. The top of the spreadsheet has the initial conditions. In the bottom half of the spreadsheet we have set up an optimization model, based on the information is the case. You should open up Solver and review how the model has been set up.

<u>Questions</u>

When the *Elite* product was introduced, the choice for feedstock had a dry weight of 36.1 #/KSF with a caliper of 6.7 mils, and 4.1 % TiO_2. The polyethylene resin had 12.5% TiO_2, and was coated on the face side at 13 #/KSF and on the wire side at 11 #/KSF.[1]

In light of the success of *Elite*, how might Apollo "re engineer" the product and process to improve its product margins? What savings are possible? What changes would need to be made? What impact might this have on product features?

What further improvements are possible if Apollo relaxed some of the marketing requirements for *Elite* paper?

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[1] The specified design requirements were not completely satisfied by this product formulation, which was of concern. In addition to reducing costs, Apollo hoped to bring the product design back into specification.