Reducing Production Cost by Optimizing the Assignment of Parts to Machines using Cost-Benefit Analysis and Monte Carlo Simulation

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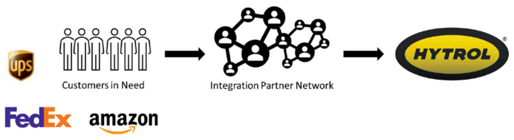
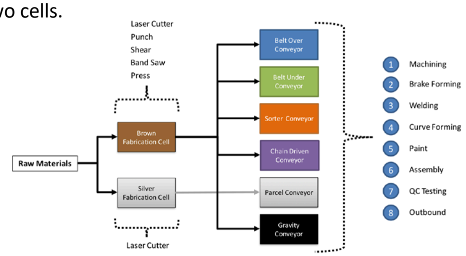
About Hytrol

Hytrol Conveyor Company, founded in 1947 by Tom Loberg, is an Engineered to Order (ETO) manufacturing company. Hytrol is one of the largest manufacturers of conveyor equipment in the United States. As an ETO company, Hytrol manufactures and designs orders for its large customer base, including Amazon, FedEx and UPS, through their Integration Partner Network. Hytrol manufactures two types of conveyors: gravity and powered. The three gravity conveyors they manufacturer are roller, wheel, and ball bearing; and the five powered conveyors they manufacture are belt over, belt under, sorter, chain driven, and parcel.

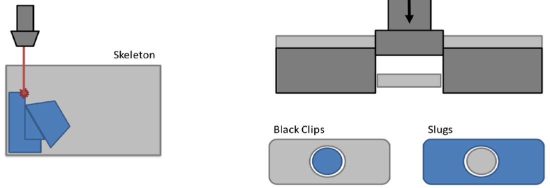


Hytrol Company Operations

During production, a part order typically experiences the same processes. When raw material arrives, it flows through the brown cell if it is belt over, belt under, sorter, chain or gravity conveyor and through the silver cell if it is a parcel conveyor. Once it leaves the brown or silver cell, the flows to its designated cell for further fabrication. Our system of interest is the laser cutting and punching operations within the brown and silver fabrication cells. Our primary objective is to reduce the amount of scrap in the two cells.

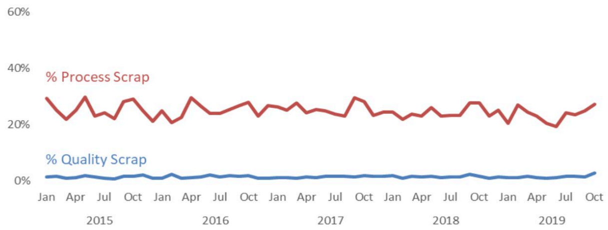


Laser cutting utilizes highly focused beams of light to cut through a single sheet of metal. Multiple parts can be cut on a single steel sheet by laser nesting. The flexibility of a laser cutter allows Hytrol to manufacture any custom designed part. However, Hytrol is concerned with the large amount of scrap produced from laser cutters. A punch forms a part by shearing metal between the upper tool and lower tool. Lasers are responsible for skeleton scrap and punches are responsible for black clips and slugs.



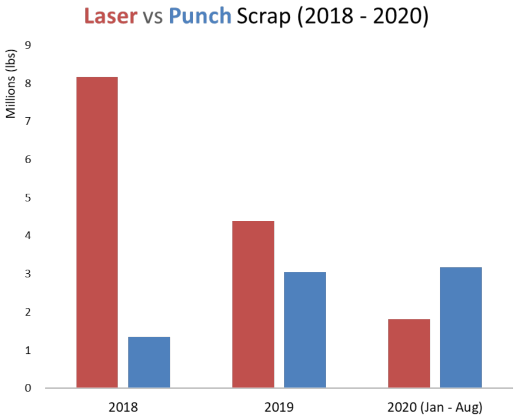
Performance Analysis

We evaluated the performance of the systems by measuring two types of scrap, process and quality. Quality scrap includes parts or assemblies that fail quality control. Process scrap is the byproduct of the machines that that fabricate the parts, such as the skeleton and black clips. Since 2015, Hytrol has spent about \$2M monthly on raw materials. About \$500K is wasted as process scrap and about \$30K is wasted as quality scrap. The greatest contributor to overall scrap within the system is process scrap which accounts for approximately 25% of the total raw material purchased while quality scrap is only 1-2%. Because process scrap is a greater contributor to cost and overall scrap, our project focuses solely on process scrap.



Root Cause of Process Scrap

Through a Pareto Analysis using scrap data from 2018-2020, we discovered the punch and laser are the primary contributors to scrap. In 2018, the laser cutter accounted for 70% of the total scrap and the punched accounted for 15%. In 2020, after Hytrol made a conscious effort to decrease the scrap produced on the laser cutter, the scrap rate decreased to 25% and the rate for the punch increased to 55%. Our team was then tasked with identifying more cost-effective opportunities that would address reducing scrap rate in the fabrication process.



Cost-Benefit Analysis of Creating Die Sets for Parts

To assist Hytrol in transitioning parts from the laser to punch, we created a cost-benefit analysis using net present value (NPV) to justify the investment. The equation utilizes the cost of the tool, the cost savings and the time savings from producing the part on the punch instead of the laser.

$$\text{NPV} = -\text{Cost of Die Set} + \text{Scrap Cost Savings} + \text{Time Cost Savings}$$

Cost of Die Set
CC = Captial cost of die set
MC = Monthly maintenance cost of die set

$$\text{Cost of Die Set} = CC + \sum_{t=1}^{n} \frac{MC}{(1+ROR)^t}$$

Scrap Cost Savings
u_t = Utilization of a part during time t
C_M = Cost per pound of raw materials
W_L = Pounds of scrap produced per part from laser
W_P = Pounds of scrap produced per part from punch

$$\text{Scrap Cost Savings} = \sum_{t=1}^{n} \frac{u_t(C_M(W_L - W_P))}{(1+ROR)^t}$$

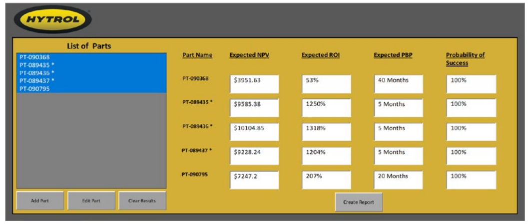
Time Cost Savings
C_L = Cost per hour of operating laser
T_L = Production time (seconds) per part for laser
C_P = Cost per hour of operating punch
T_P = Production time (seconds) per part for punch

$$\text{Time Cost Savings} = \sum_{t=1}^{n} \frac{u_t(C_L T_L - C_P T_P)}{(1+ROR)^t}$$

$$\text{NPV} = -CC + \sum_{t=1}^{n} \frac{u_t[C_M(W_L - W_P) + (C_L T_L - C_P T_P)] - MC}{(1+ROR)^t}$$

Excel Decision Support Tool

Our tool provides Hytrol decision makers with the ability to identify the optimal parts that are best suited for the punch to minimize production costs.



Impact Analysis

Using our tool on only 5 parts, we uncovered about \$40,000 worth of savings over a 7-year time horizon. This tool can be applied to any of Hytrol's unique parts to identify the parts with the most savings potential.

Part Name	E(NPV)
PT-090368	\$3,951.63
PT-089435	\$9,585.38
PT-089436	\$10,104.85
PT-089437	\$9,228.24
PT-090795	\$7,247.20
Total	**\$40,117.30**