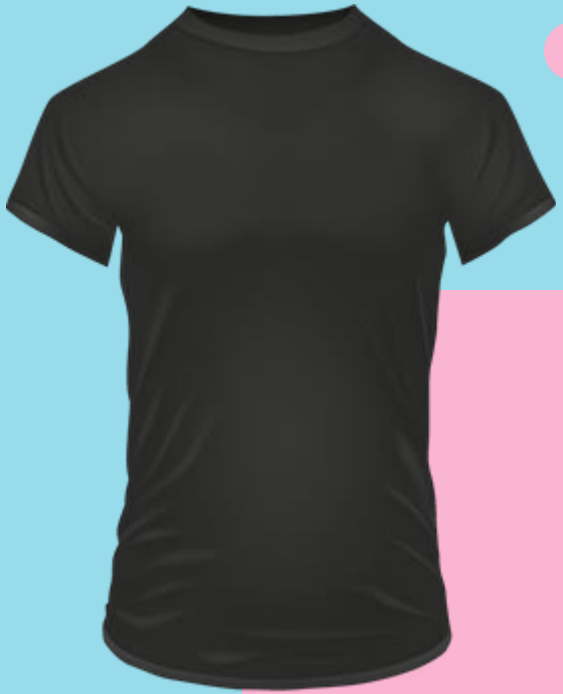
T-SHIRT PRINTING

Optimizing Screen-Printing Operations for Spring 2025 Collection

Mixed Integer Programming



INTRODUCTION

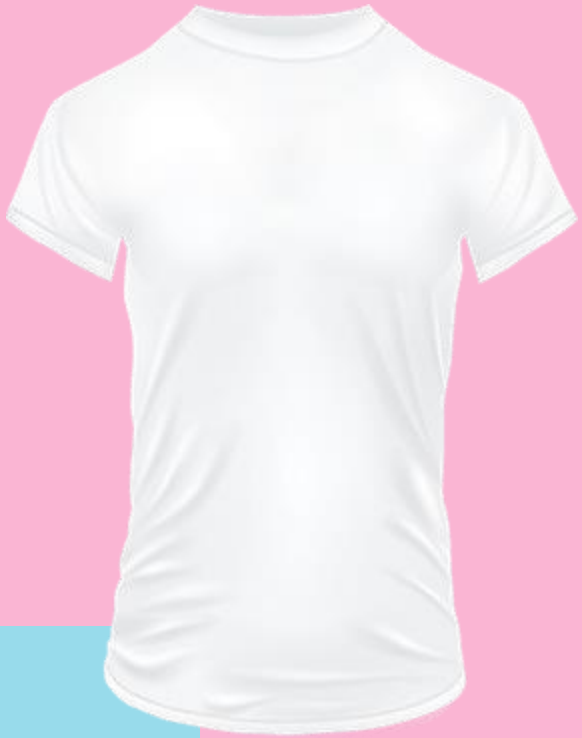
Manufacturing production floors are dynamic environments, making them ideal for the application of MI Programming.

The manufacturing process often requires to balance priorities and optimize resource allocation, aligning with the strengths of MIP Optimization.

Manufacturing process challenges include:

- Time Constraints.
- Machine Constraints.
- Labor Constraints.

This project explores the application of MIP optimization to a real-world manufacturing problem.



DESCRIBING MIP PROBLEM

Role in Company?

- As Production Manager, I oversee an industrial screenprint shop.
- Production is time-sensitive, cost management is critical for the success of our company.

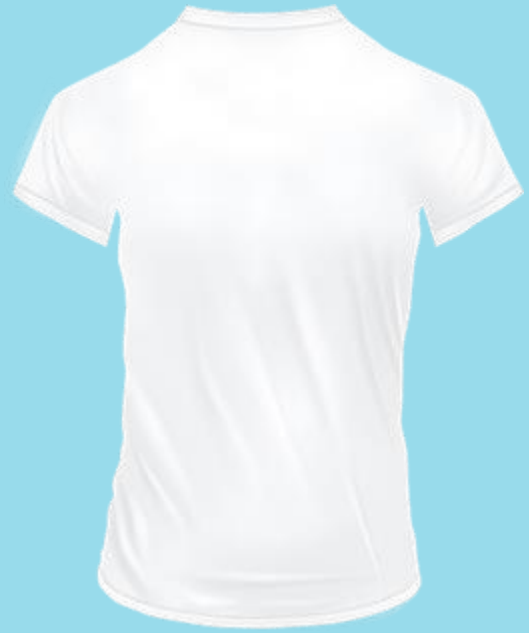
What is required?

- A new order comes in from a client, they want to print the Spring 2025 collection.
- The order is 1 million pieces overall.
- The collection has 25 designs, designs range from 3 colors to 18 colors.
- Each design has a specific number of pieces to print.

Designs Breakdown

- Provided by customer:

Design	Amount of Colors in Design	PIECES TO PRINT
D1	3	31548
D2	4	75475
D3	12	10908
D4	8	51310
D5	12	4533
D6	12	103918
D7	7	48537
D8	12	52959
D9	16	710
D10	14	70386
D11	7	13164
D12	12	38048
D13	14	2688
D14	14	121016
D15	11	31889
D16	16	9817
D17	16	46304
D18	17	17830
D19	15	26943
D20	18	12388
D21	13	60256
D22	18	50722
D23	17	5279
D24	18	81181
D25	5	32191



01 OBJECTIVE

Develop an MIP model to allocate designs in machines to **maximize profit.**

02 VALUE OF THIS MODEL

Helps the production floor meet deadlines and profit goals while optimizing resource utilization.

PRODUCTION FLOOR / MACHINE BREAKDOWN

9 Production Machines

- Each production machine has a different number of colors it can print.
- Each machines produces at a different speed.
- The fixed cost per machine are the same.

Machine	Maximum Amount of Colors a Machine can print	Output (pieces/hour)	Fixed Cost per Hour
M1	12	600	$150
M2	12	600	$150
M3	14	590	$150
M4	14	590	$150
M5	16	575	$150
M6	16	575	$150
M7	16	575	$150
M8	18	550	$150
M9	18	550	$150

MIP MODEL OVERVIEW

Model Purpose	To allocate designs to machines, considering constraints and costs, and achieve **maximum profitability.**
Decision Variables	Assignment of designs to machines.
Objective Function	Maximize profit = Revenue – Costs.
Constraints	1. Each design is assigned to only one machine.
	2. Machines can only handle designs within their color capacity.
	3. Balance workload across machines (no machine can work more than 25% than another machine).

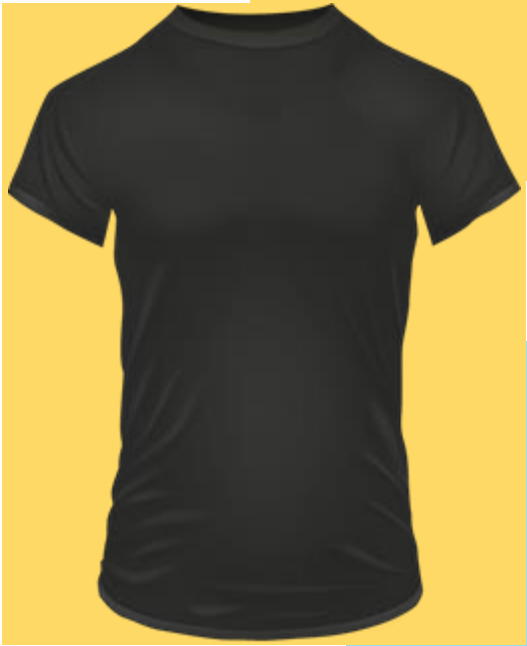
MODEL VALUE / SCALING OPTIMIZED MODEL

PYTHON OPTIMIZATION MODEL OUTPUT

When the optimization for model is run, the design / machine assignment is:

Machine Performance Summary:

Machine	Designs Assigned	Total Pieces	Profit ($)
M1	D2, D4	126785	12674.50
M2	D5, D8, D12, D15	127429	12727.23
M3	D13, D14	123704	11836.90
M4	D1, D7, D11, D25	125440	12005.14
M5	D6	103918	9258.26
M6	D9, D10, D19	98039	8723.26
M7	D17, D21	106560	9488.07
M8	D3, D16, D18, D22, D23	94556	7279.93
M9	D20, D24	93569	7218.33



FOUR IDEAS

Solutions

MIP ensured fair workload distribution.

Accurate cost calculations informed optimal design assignments.

Challenges

Balancing workload across machines.

Managing variable costs (setup and ink) efficiently.

Next Steps

Sensitivity analysis to assess profit impact under varying machine costs.

Scenario analysis for different client orders.

Extensions

Incorporate machine learning to predict optimal allocation strategies for future orders.

Build a user interface for real-time order allocation visualization.