DES approach for evaluation and estimation of production parameters

Rahul Kumar
Institute of Informatics
Slovak Academy of science
Bratislava Slovakia

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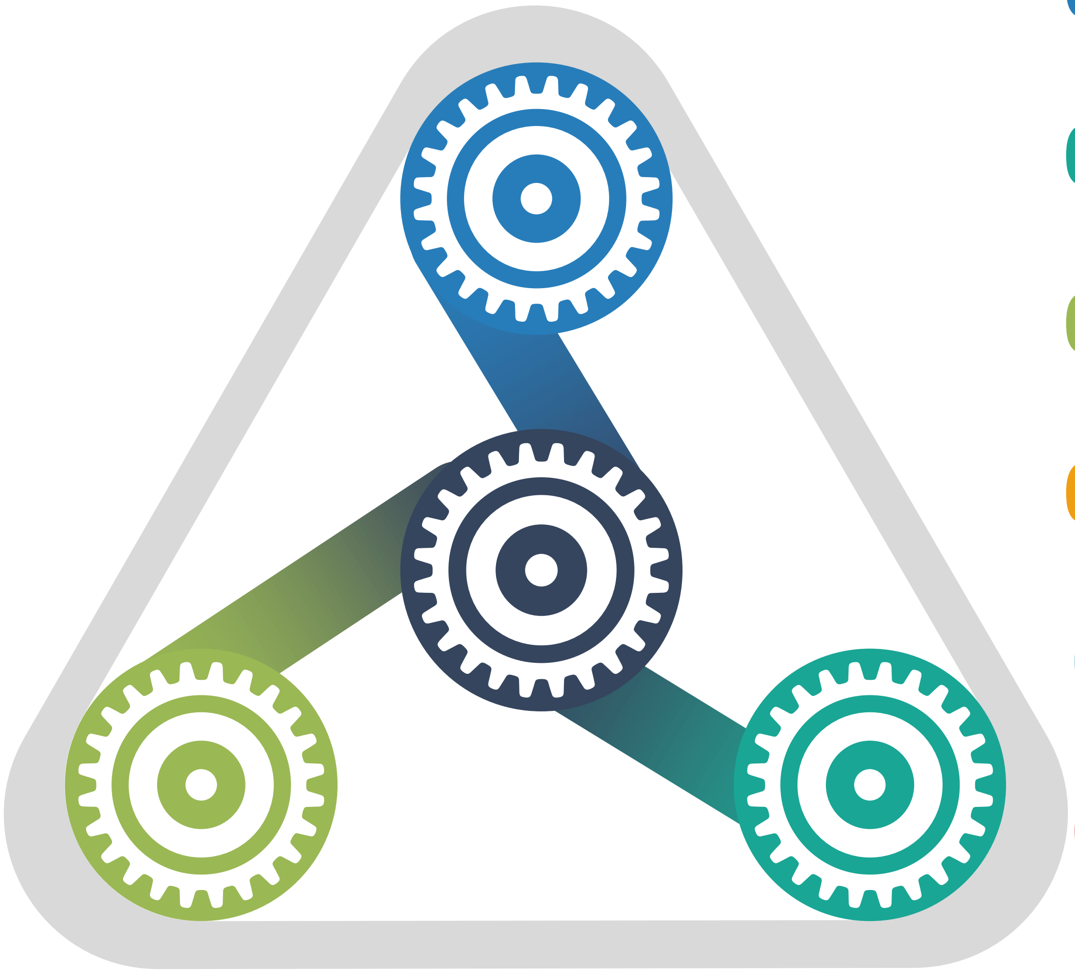


Introduction

Objective

- Effective use of inputs like materials, resources, labors etc.
- Effective distribution of work for proper utilization of machines

Production Planning

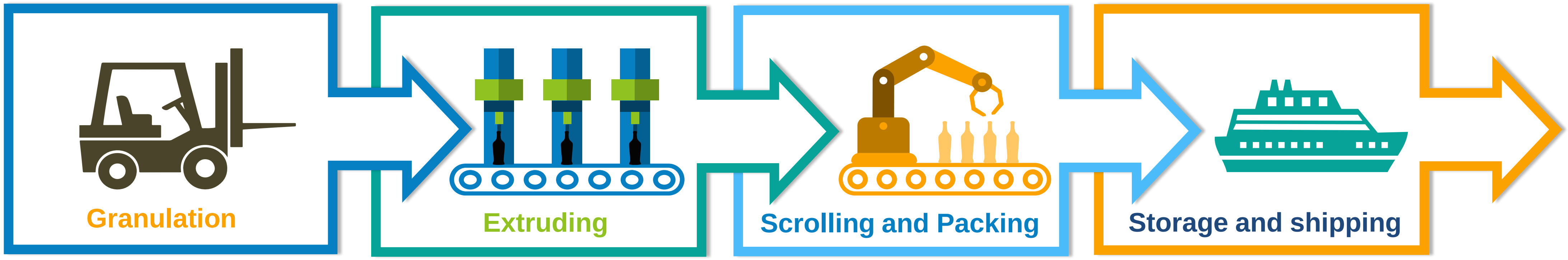
"The planning of industrial operations involves three considerations, namely, what work shall be done, how the work shall be done and lastly, when the work shall be done" by Kimball

Production Control

"Production control refers to ensuring that all which occurs is in accordance with the rules established and instructions issued." by Henry Fayol

Plastic foils recycling line

Process Description



Granulation

- Granules are produced from waste foils which is cut into small pieces, washed and dried.
- Polymerization process converts these waste foils into granules.

Scrolling and Packing

- Foils so produced are scrolled and packed to produce plastic bags of quantities in the scrolling lines.

Extruding

- Process of blowing the granulates into foils is known as Extrusion. Foils of required thickness and width can be produced.

Storage and shipping

- Produced foils are stored in the Warehouse until delivery shipping

Granulation

- Different types of Low Density Polyethylene granules.



Extruders

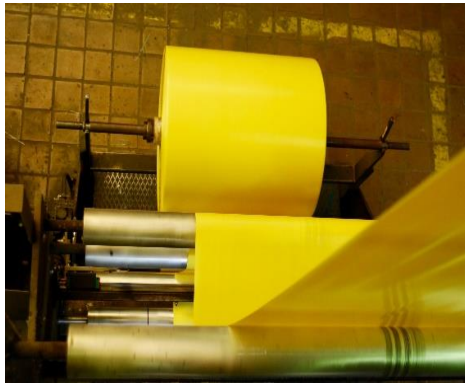
- Extruding or Blowing process.
- Granules are extruded to foils or different width, thickness and color



Pictures provided by the MAT Obaly, a.s.

Foil Rolls

- Rolls of foils are made to the end of extruding process
- The rolls are changed when the predefined limits of machine is reached


Scrolling and Packing

- Foil rolls are scrolled and packed to desired shapes and dimension required.



Pictures provided by the MAT Obaly, a.s.

Process description

Extruders

- Four non identical extruders of different specification and capacity is considered.
- Each Extruder can be set to produce foils of any width, thickness and color.

Machine reconfiguration

- Setting up machine for starting of production.
- Roll and sieve change
- Reconfiguring machines for new orders

Shift and Operators

- 24 hours operation in 3 shifts per day and 1 operator managing the process during the shift

Failures

- Machine failure and breakdown happens occasionally which interrupts production process

Schedulling optimization problem formulation

Make span

Total time taken by the machines to finish the task scheduled rep as.

Parameters of Order

Each order contains certain information like width, thickness, color, delivery date, quantity rep as.

Reconfiguration time

Time taken by operator to reconfigure machine can be rep as.

Processing time

Total processing time of an order can be rep as.

Lateness

Lateness of an order can be rep as

Objective Function

Total make span minimization being the primary goal together with reducing total number of reconfigurations executed and total amount of wastage in materials while

$$\min \quad C_{\max}, \sum_{m \varepsilon M} S_{\mathrm{m}}, \sum_{m \varepsilon M} W_{\mathrm{m}}$$

$$\text{s.t.} \quad J_{\mathrm{o_m}} \leq 1, \; for \; o \; \varepsilon \; O, m \; \varepsilon \; M$$

$$\sum_{m \varepsilon M} J_{\mathrm{mo}} t s_{\mathrm{mo}} \leq C_{\max}$$

$$L_{\mathrm{o}} \leq 0, \; for \; o \; \varepsilon \; O$$

Description of methods

Scheduling orders

- Orders are placed on extruders depending on order requirements and machine constraints
- Always it is made sure that the orders with lowest delivery time is not placed on the slowest machine.

Scheduling without splitting orders

- Orders are placed on a machine until it is completed.
- Machine utilization was observed to considerably less.

Scheduling with splitting of orders

- Orders are placed by splitting it.
- Orders with low delivery times are kept without splitting.

Comparison

- Scheduling without splitting is found to reduce number of reconfiguration of machines and considerable reduction in losses.
- Scheduling with splitting reduces the overall production time and improves the machine utilization.

SAMPLE OF ORDERS

Orders	Thickness	Width	Colour	Quantity	Time
O_1	0.35	400	blue	2000	3
O_2	0.30	350	red	2500	3
O_3	0.45	500	white	1000	4
..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..
..	..	..	..	..	..
O_{n-1}	0.35	300	red	1500	7
O_n	0.40	450	green	2500	8

Heuristics for optimization

- Heuristic algorithm is developed to place the orders on the machine
- Algorithm generates the schedule iteratively using the formulated rules which satisfies the constraints.
- Orders with the lowest due date is placed on the slowest machines.
- A factor x determines the percentage of orders placed without splitting
- The algorithm calculates remaining quantity and equivalent time required by the machine to produce.
- Approach make sure that splitted portions of the order is not placed on a machine more than once.

Algorithm 1: Heuristic approach for non-identical parallel machine scheduling

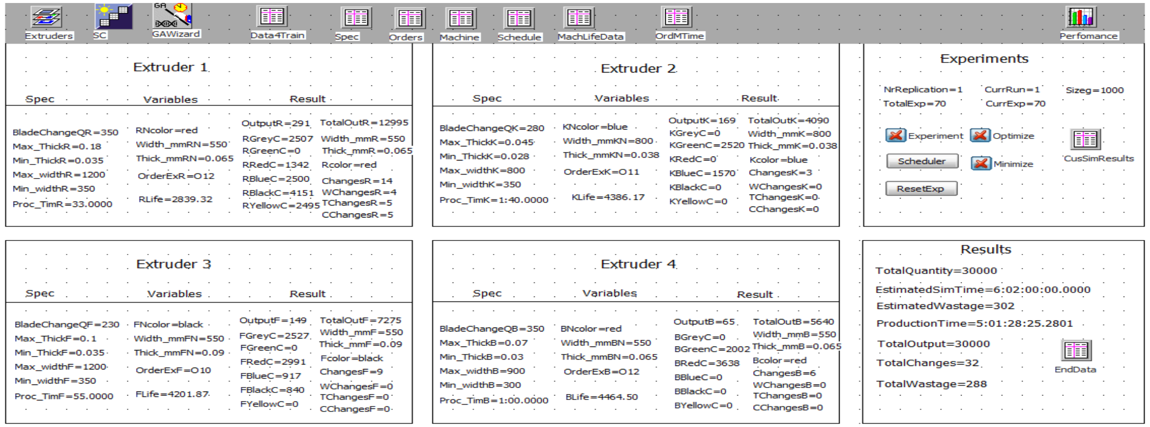
Scheduling function (a, S);
Input : Machine working hour distribution matrix a
Output: Schedule S
while $Completed < x * Orders$ **do**
  Assign orders from matrix a without splitting;
  Machines are choosen random;
  Slowest machine is exempted for order with earliest due date;
  return s;
end
while $Completed \,!= Orders$ **do**
  Assign orders with splitting orders;
  Machines and orders are choosen randomly;
  Slowest machine is assigned with minimum number of orders;
  Same order is not placed more than once on a machine $J_{o_m} \leq 1$;
  return S;
end

Simulation Model

- Extruding process is modelled in Technomatix Plant Simulation Software

- Four extruders are modelled as per machine specification and including machine failure probability.

- Roll change and Sieve change are included in the model.



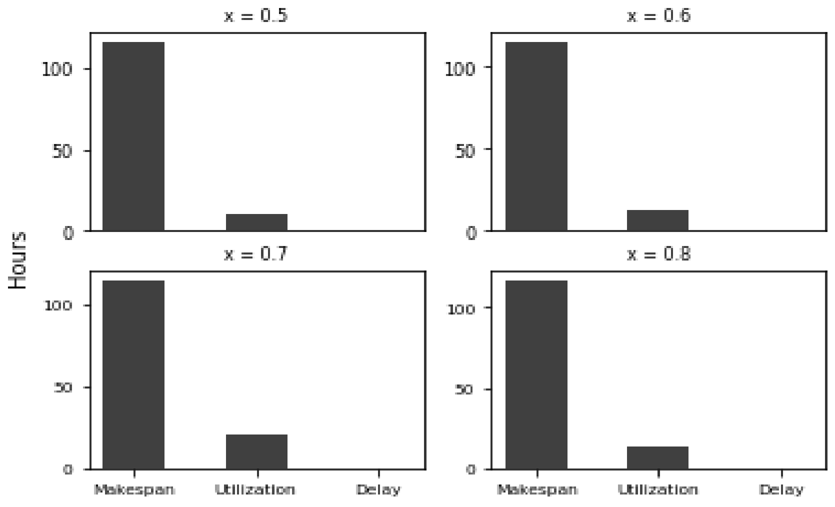
- Uniform distribution is used to determine the change intervals and time taken to make a change

- One operator is available in each shift modelled with different efficiency.

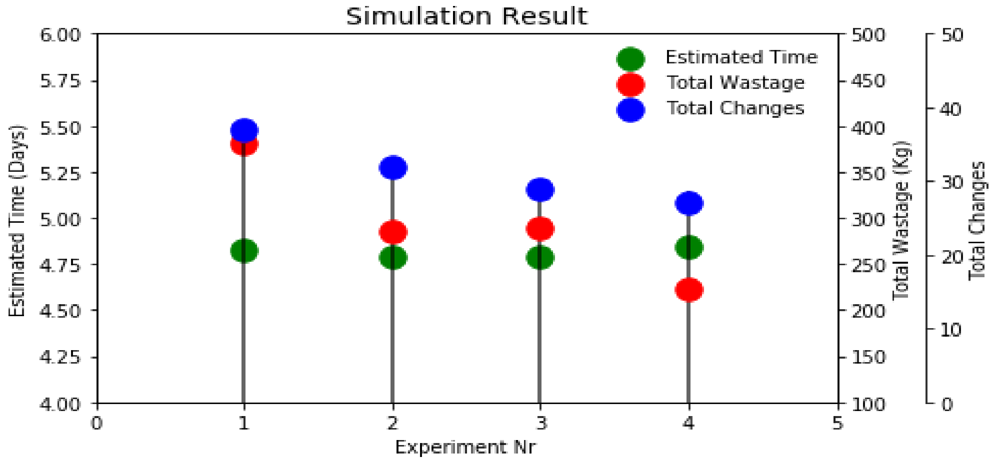
- A separate user interface is available to evaluate KPI.

Analysis of Experimental Results

- Schedule generated combining non splitting and splitting of orders is expected to have higher reconfigurations.
- Machine and resource utilization is improved.
- Effect of varying the percentage of orders assigned with splitting for four different cases is as illustrated.
- The optimal solution of all four cases satisfied the due time constraint of orders.



- Optimal schedules were imported to Simulation model and tested.
- Production time is estimated considering all the real world outrages in the system, modelled in the platform.
- Total Wastage in the input granules is also estimated.
- The Simulation run helps in analyzing the impact of process interruptions in production planning and accommodating it.



Conclusion

- Proposed heuristic approach generate optimal allocation of orders on non identical parallel machines minimizing the multi objective function and keeping the constraints satisfied.
- Simulation model estimates the total wastage in input resources and total production time of the generated schedule which assists in proper planning and control of manufacturing process

Future Works

- Predicting the life of machines to consider machine failure in production planning
- Predicting intra-logistic service efficiency
- Exploring capabilities of agent based optimization methodologies

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Thank You for your attention

If any questions or comments please contact author at upsyraku@savba.sk