BOSS HUGO BOSS

YASAR UNIVERSITY

GROUP MEMBERS
Göksu Erseven, Gizem Akgün, Selin Gökkaya, Aslıhan Karakaş, Anıl Tekye, Gözde Yarıkcan, Sinan Maramuroğlu

ACADEMIC ADVISORS
Adalet Öner
Özgün Öztürk

COMPANY ADVISOR
Erim Kırca

PERMUTATION FLOW SHOP SCHEDULING PROBLEM

MACRO ANALYSIS

Hugo Boss İzmir Factory

- 176 000 m2 total area
- 3800 employees
- Almost 6100 sales points -- 110 countries

SYMPTOMS

- Currently schedules are prepared manually.
- Efficiency of schedules depends on experience and judgement of the planner
- There is no systematic and/or scientific methods employed in scheduling process

PROBLEM DEFINITION

- Each quality control request corresponds to a job.
- Quality control stages (stations) correspond to machines.
- Each job has the same route through 7 machines (control stations)
- The length of time that jobs spend on machines is taken as the amount of time workers spend each time in the control phase.
- At all stages, it is assumed that there is a predetermined worker.
- The order of the machines in which the job is processed is the same for every job.

TARGET

Better quality control job scheduling

MICRO ANALYSIS

TPC (Technical Preparation Center)
In this section, the production stages and processing times of the new product models are determined.

Verarbeitung
Before the production of these products made in the TPC begins, the products are sent to the 'Verarbeitung' section to pass the quality and control processes.

MATHEMATICAL MODEL FORMULATION

MANNE'S MODEL

Decision Variables
Dj,j' = Binary variable with Dj,j' = 1 if job j is scheduled before (not necessarily immediately before) job j', $D_{j,j'}$ = 0 otherwise, $j < j'$
Cij = Completion time of job's j operation on machine i
$Cmax$ = Finishing time of the last operation on machine m

Parameters
pij = j Processing time of job j on machine i
M = Large numb

Indices
i Machine index, i = 1,.....,m
j Job index, j = 1,.....,n

minimize
Cmax

Mathematical Model

$$\min C_{max}$$

s.t

$$C1j \geq p1j \qquad j=1,.....,n$$

(1) the completion time of any j job is bigger than or equal to the processing time for machine 1.

$$Cij - Ci\text{-}1,j \geq pij \qquad i = 2,...,m;\ j=1,...,n$$

(2) the completion time difference of any j job between two successive machines (i-1, i) is equal to or greater than the processing time in the i-th machine of the same job j.

$$Cij - Cij' + M.Dj,j' \geq pij \qquad i=1,...,m;\ j,j'=1,....,n,\ j<j'$$

$$Cij - Cij' + M(Dj,j'-1) \leq -pij' \qquad i=1,...,m;\ j,j'=1,...,n,\ j<j'$$

(3) The constraints (3) and (4) include the machine availability constraints.
(4)These constraints define the precedence relationship between the j jobs in any i machine.

$$Cmax \geq Cmj \qquad j=1,...,n$$

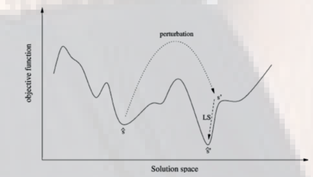
(5) Constraint (5) is represents the makespan is equal or bigger than the maximum completion time of all jobs on the last machine.
Constraints (6), (7), (8) are the non-negativity constraints.

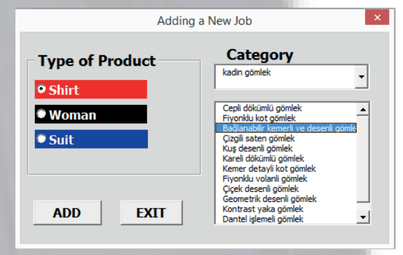
$$Cmax \geq 0$$
$$Cij \geq 0$$
$$pij \geq 0$$

HEURISTIC SOLUTION METHODS

NEH
(Nawaz, Enscore, Ham)

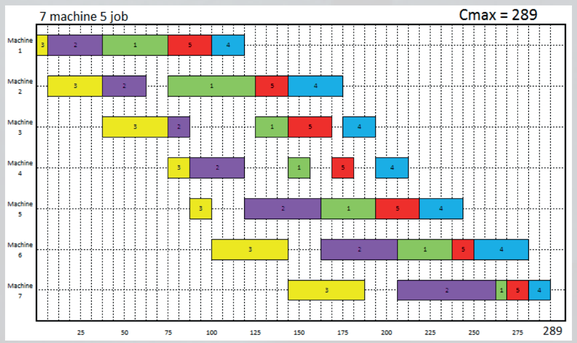
ILS
((Iterated Local Search)



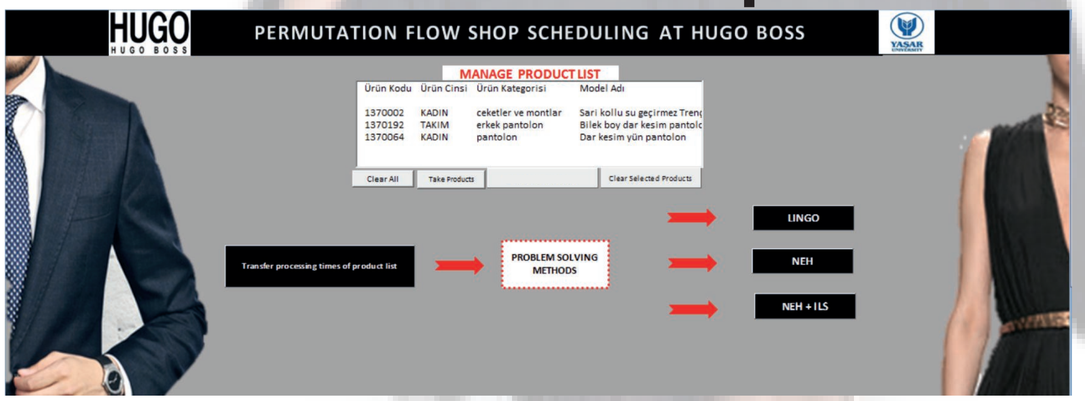


LITERATURE

- Pinedo (2002): permutations of jobs and the order which they are to be processed
- Manne (1960): flow shop scheduling problem - MIP Model
- Tseng (2004): permutation flow shop scheduling problem
- Feng Jin, Shiji Song and Cheng Wu (2005): NEH is the most intuitive method for flow shop scheduling problem
- Stützle (1998): ILS is an important meta-heuristic algorithm that improves local search algorithms



Örnek Problemler	Cmax		
	NEH	NEH+ILS	OPTIMAL
7 machine 5 job	75	73	73
8 machine 5 job	80	80	80
5 machine 10 job	99	99	98
6 machine 10 job	107	105	105
7 machine 10 job	122	119	119
8 machine 10 job	127	125	121
6 machine 15 job	164	161	-
7 machine 15 job	168	160	-
8 machine 15 job	176	170	-
6 machine 20 job	185	183	-
7 machine 20 job	213	213	-
8 machine 20 job	236	236	-
8 machine 30 job	314	311	-
8 machine 40 job	400	397	-
8 machine 50 job	474	468	-



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• Manne, AS (1960). On the job-shop scheduling problem. Operations Research,8,219-23. • Pinedo, M (2002). Scheduling – Theory, Algorithms, and Systems. Upper Saddle River, New Jersey: Prentice-Hall. • Stützle,T. (1998). Applying iterated local search to the permutation flow shop problem. FG Intellektik, TU Darmstadt. • Feng Jin, Shiji Song & Cheng Wu. (2007). An improved version of the NEH algorithm and its application to large-scale flow-shop scheduling problems. IIE Transactions, 39:2, 229-234.