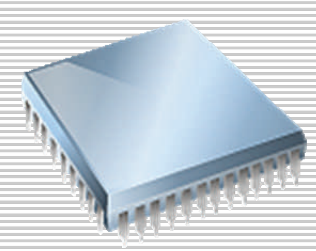
TECH Semiconductor Singapore Pte Ltd

Company Background

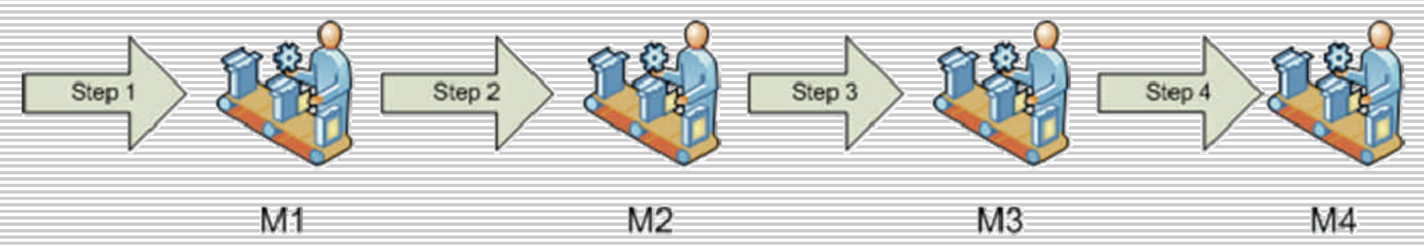
TECH Semiconductor Singapore is a leading, joint-venture 300mm wafer fabrication plant. It was set up in 1991 to specialize in manufacturing Dynamic Random Access Memory (DRAM). TECH's DRAM process uses advanced cutting-edge technology-deep UV steppers, scanners, advanced dry etch processes, CMP (Chemical Mechanical Polishing), new advanced techniques of metallization and sub-quarter micron technology. Their final DRAM products are used as memories in Computers, Servers & Workstations, Communications Electronics Military, Aerospace Electronics, Automotive Electronics, Office Automation Equipment and Video Games.

Problem Definition



- To schedule preventive maintenance (PM) for TECH's 100+ machines in the production line
- To automate the PM scheduling process
- To optimize PM scheduling in order to maximize system throughput and minimize inventory cost

Methodology & Approach



- **Mixed Integer Programming (Optimization)**

Objective:

$$\max \sum_{t=1}^{T}\left(\sum_{e=1}^{E}\left(b_e \cdot \min[K_e V'_e(t), I_e(t)] - c_e^I \cdot I_e(t)\right) - \sum_{i=1}^{M}\sum_{l=1}^{\rho_i} c_i^l \cdot a_i^l(t)\right)$$

Subject to:

$$\sum_{t=w_i^l}^{u_i^l} a_i^l(t) = 1, \text{ for those PM tasks that have to be finished in the time window } [w_i^l, u_i^l] \subseteq [1,T]$$

$$V_i(t) = f_i\left(\underline{a}_i(t), \underline{a}_i(t-1), \dots, \underline{a}_i(t-(k_i-1))\right)$$
$$\text{for } i = 1,\dots,M;\ t = 1,\dots,T;\ \underline{a}_i(t) = 0, \text{for } t \le 0$$

$$\sum_{i'_e = i} V'_e(t) = V_i(t), \quad \text{for } i = 1,\dots,M$$

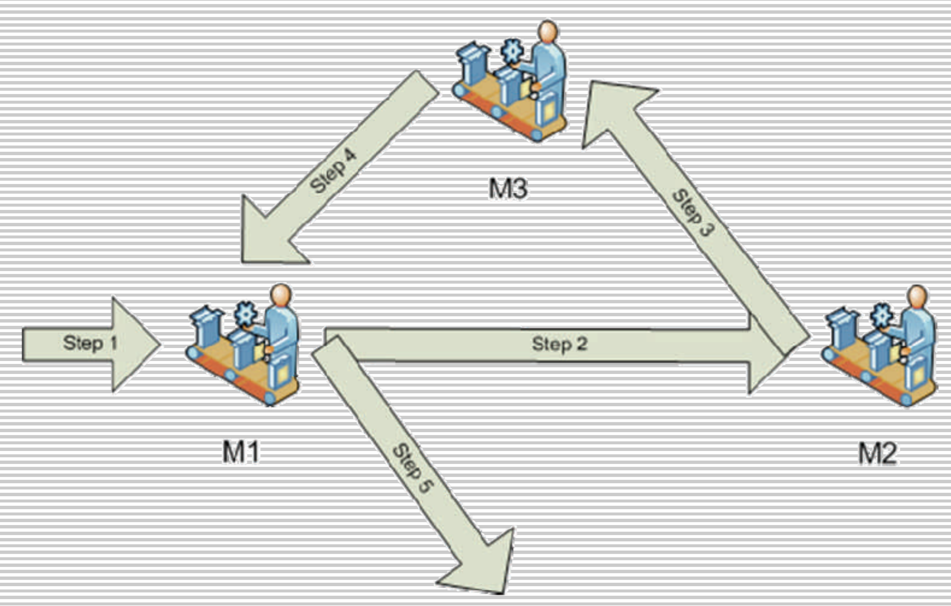
$$R^j(t) \ge \sum_{i=1}^{M} r_i^j\left(\underline{a}_i(t), \underline{a}_i(t-1), \dots, \underline{a}_i(t-(k_i-1))\right),$$
$$\text{for } t = 1,\dots,T;\ j = 1,\dots,N;\ \underline{a}_i(t) = 0, \text{ for } t \le 0,\ d_0(t) = D(t)$$

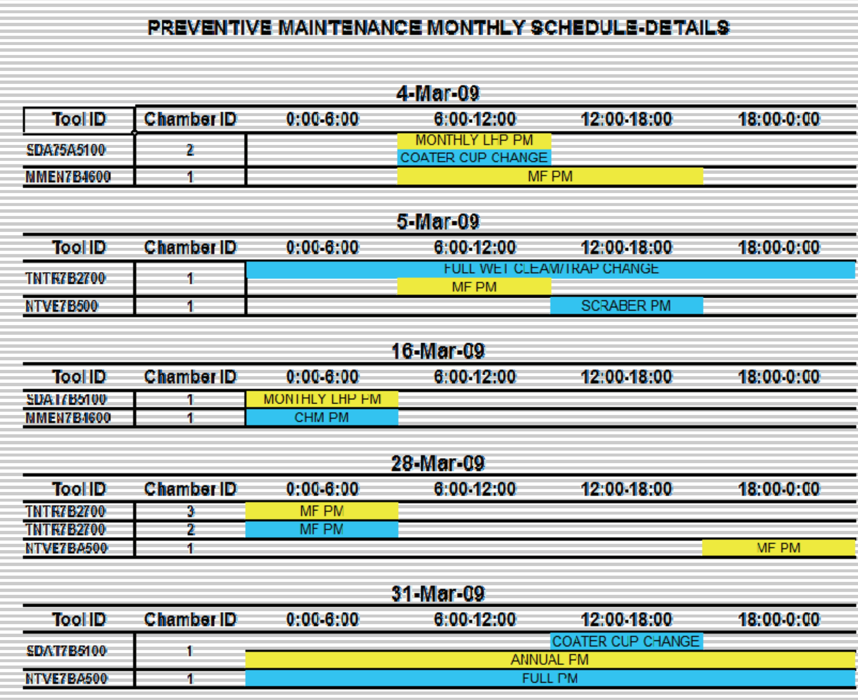
$$I_e(t+1) = \left(I_e(t) - K_e \cdot V'_e(t) + d_e(t)\right)^+$$
$$\text{for } e = 1,\dots,E;\ t = 1,\dots,T-1,\ d_{e+1}(t) = \min[K_e V'_e(t), I_e(t)],$$
$$\text{for } t = 1,\dots,T;\ e = 1,\dots,E-1$$

$$I_e(t) \le L_e, \quad \text{for } e = 1,\dots,E;\ t = 1,\dots,T.$$

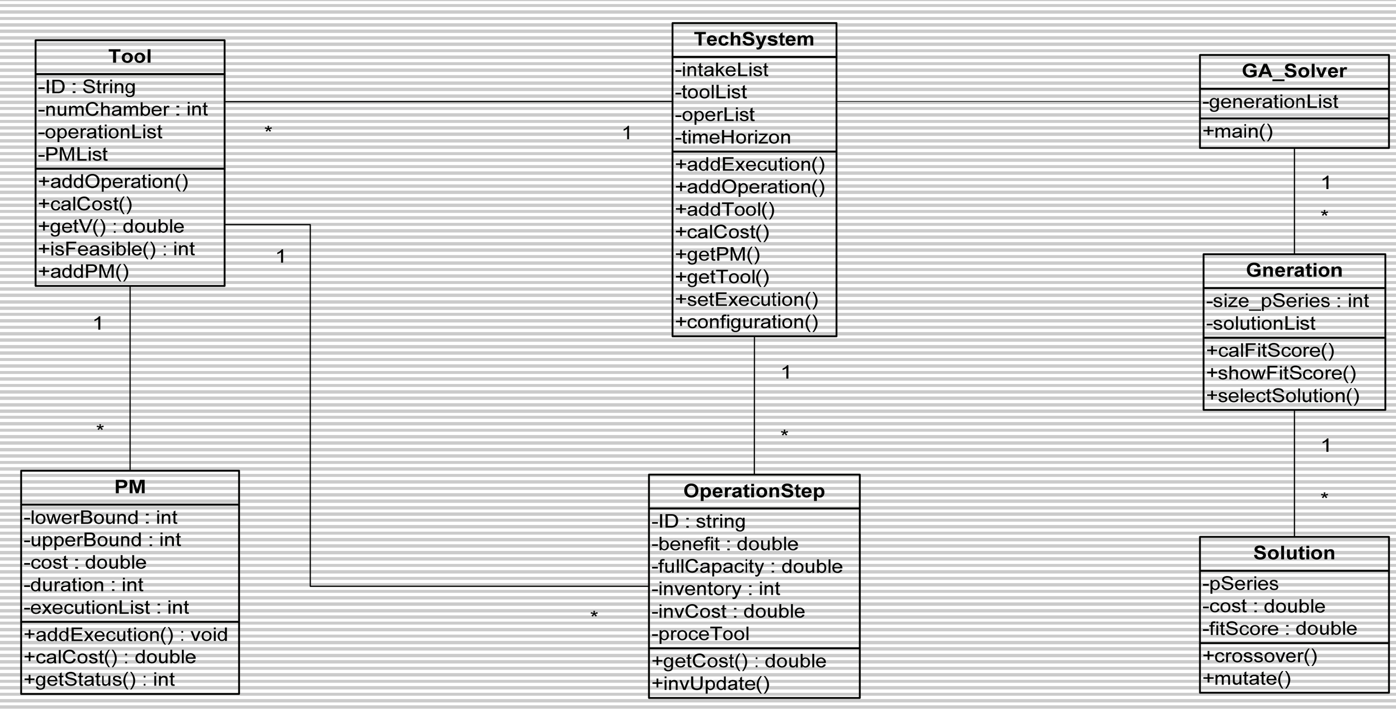
Parameters

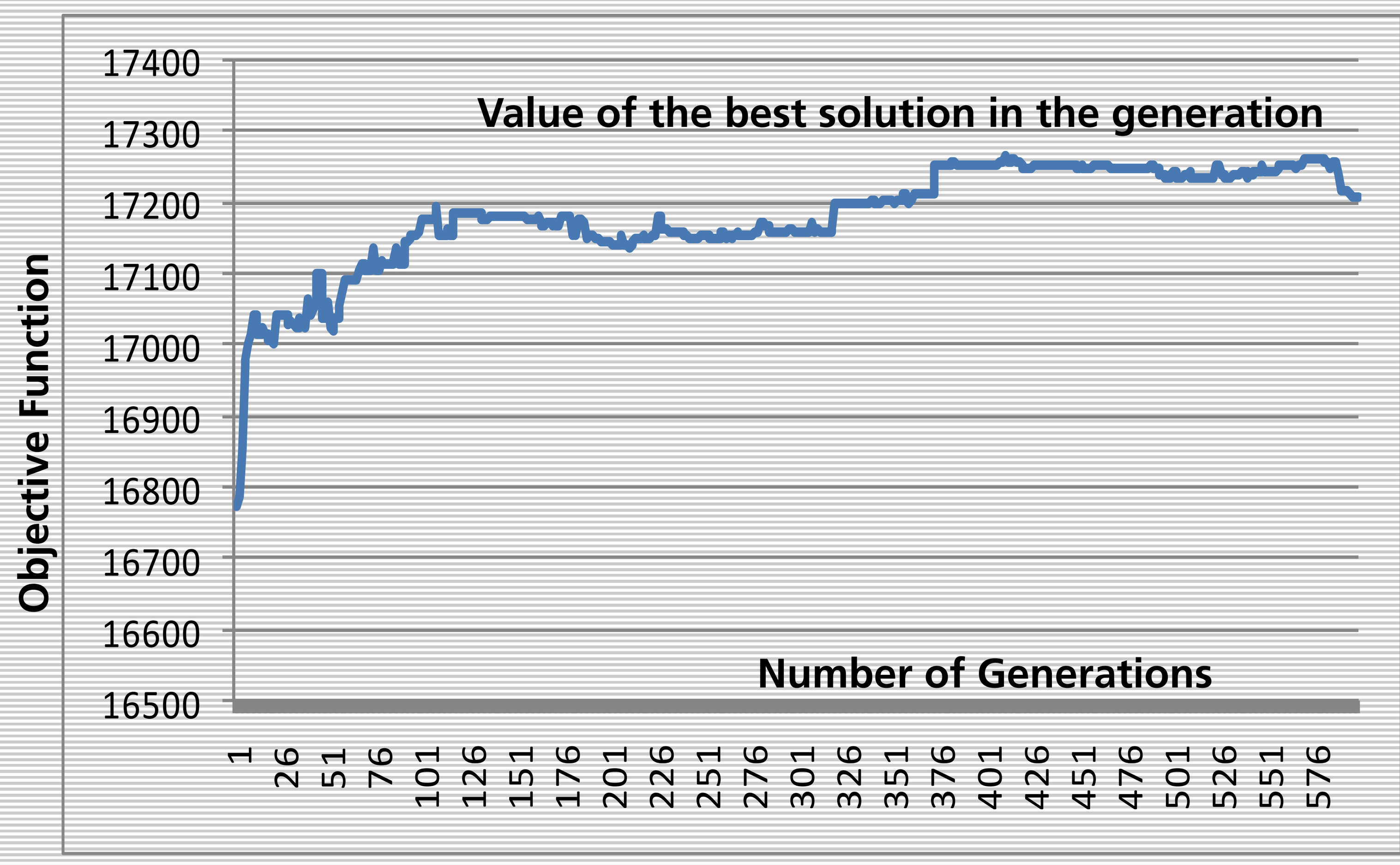
M	Number of tools considered.
T	Number of time units in the planning horizon.
N	Number of source types considered.
E	Number of steps considered.
i'_e	The tool processes step e.
ρ_i	Number of PM tasks on tool i.
w_i^l, u_i^l	Time window [min, max] associated with PM task l on tool i.
k_i	Number of periods for the PM task with the longest duration on tool i.
b_e	Profit coefficient for processing one wafer on tool i'_e in step e.
c_e^I	Cost coefficient for inventory on step e.
c_i^l	PM cost for performing PM task l tool i.
L_e	WIP buffer size for step e.
K_e	Coefficient of wafer throughput for tool i'_e's availability for step e.
$f_i(\cdot)$	Availability function for tool i; constructed from the "configuration matrix"
$r_i^j(\cdot)$	Resource function calculating the requirement of resource type j for tool i $j = 1,\dots,N$; constructed from a resource requirement matrix.
$R^j(t)$	Amount of resource type j available in period t, $j = 1,\dots,N$.
$D(t)$	Amount of wafer coming (WIP) to step one.





- **Genetic Algorithm (Heuristics with JAVA programming)**





(the graph is resulted from testing data)

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