Application of Optimization-Based Production Loading at Toshiba Corp.
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Background
- UMD and Toshiba have collaboratively developed advanced Available to Promise (ATP) and Production Capacity Planning (PCP)
- Optimization-based Production Loading (OPL) extends ATP to shop-floor level by considering detailed production information.

Experimental Comparison with a Commercial Dispatching Rule Based Scheduler (DRBS)
- Data was collected from an electric appliance company
  - OPL time horizon: 15 days
  - Total number of machines: 80
  - Total number of dies: 870
  - Total number of component types: 2 (black or white)
  - Possible component, machine die combination: 1300
  - Variation of the total number of orders per day: 1 ~ 287
  - Quantity variation of orders: 750 ~ 210,000
- Total computation time of SPL including pre-possessing, database loading at Toshiba Corp.
  - Background
  - Experimental Comparison with a Commercial
  - Mixed Integer Programming (MIP) Formulation
    - Material change from black (B) to white (W) should be done in parallel with die change, unless initial matl is B and there is no W with initial die.
      - Objective Function
        - Due date violation + Inventory holding cost + Change-over time
      - Major Decision Variables
        - \( C_j(t,t') \): Quantity committed for component \( j \) in time period \( t \).
        - \( Q_{m,d,j}(t) \): Quantity produced by using of machine \( m \), die \( d \) and component \( j \) in time period \( t \).
        - \( O_m(t) \): Total changeover time on machine \( m \) in time period \( t \).
        - \( Z_{m,d}(t) \): Die indicator, equal to 1 as die \( d \) is allocated to machine \( m \) in time period \( t \).
        - \( \hat{Z}_{m,d}(t) \): Ending die indicator, equal to 1 as die \( d \) is allocated to ending die to machine \( m \) in time period \( t \).
        - \( X_{m,d,j}(t) \): Material change indicator, equal to 1 as there is material change-over between component group \( j' \) at machine \( m \) and die \( d \) in time period \( t \).
      - Major Constraints
        - Demand commitments:
          \( \sum_{t' \in T} C_j(t,t') \cdot L_j(t') \cdot r_j(t') \)
        - Production conservation:
          \( I_j(t) \cdot L_j(t) \cdot r_j(t) \prod_{t' \in T} C_j(t,t') \prod_{m \in M \cap D} Q_{m,d,j}(t) \)
        - Capacity balance:
          \( \sum_{t' \in T} Q_{m,d,j}(t') \cdot r_m(t') \cdot r_d(t') \cdot r_j(t') \prod_{j \in J} C_j(t,t') \prod_{m \in M \cap D} Q_{m,d,j}(t) \)
        - Changeover calculation constraints
          - Available combinations of die and machine for each component
          - Ending die for each machine and day
- Concept of OPL
  - Model should determine optimal daily production schedule for each production stage based on Final Assembly and Testing requirements.
  - The goal of this project is to develop optimization-based OPL prototype to reduce production lead-time and total inventory level, to improve throughput and order commitments (customer service level).

Single-Stage OPL (SPL) and Motif
- Develop OPL prototype for single bottleneck stage
- A factory producing electronic appliance from Toshiba Corp. is selected as motif for the development.
- One product can be produced with multiple available combinations of machine, die (injection module), and material.
- Changeover loss including die changeover and material changeover when switching products are significant.

Scope of SPL
- Production Lot Sizing
  - Total number of lots in SPL is 14.5% less than the ones in DRBS.
- Changeover Loss:
  - Total changeover time can be reduced 18.2% by using SPL compared to DRBS.
- Demand Commitment:
  - Total quantity of the violated orders and left-over orders is reduced 6.2% by using SPL compared to DRBS.

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<thead>
<tr>
<th>Number of lots</th>
<th>DBS</th>
<th>SPL</th>
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<tbody>
<tr>
<td>Average lots</td>
<td>DRBS: 662</td>
<td>SPL: 770</td>
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