Garment Production Management

Week 3

Garment manufacturing process

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Recap-previous week

- Definition of garment manufacturing systems
- Types of garment manufacturing systems
- Unique features of each garment manufacturing system

Lecture Learning Outcomes

1. Understand garment manufacturing process
2. Identify key garment manufacturing procedures
3. Understand Cut order planning concepts
4. Describe the various techniques of assembly line balancing techniques

Introduction

Session outline

- Definition garment manufacturing processes
- Procedures in garment manufacturing
- Detail steps in each garment manufacturing department
- Cut order planning (COP)
- Assembly line balancing (ALB)

Introduction

Garment manufacturing process

- It is a labor intensive, complex and multi-step procedure with various stages (design to final product)
- The garment manufacturing business has a stringent pressure
  - Consumers demand in garment business is more variety in product lines
  - Retailers expect faster delivery, better quality and lower costs
- The garment manufacturing process starts by sourcing finished fabric from the dyeing or processing industry
- To remain competitive, effective planning and execution is required

Key garment manufacturing steps

- Customer order received
- Evaluation of the order requirement (specification sheet)
- Order approval process (sample pattern and sample garment making)
  - Many samples and approval stages by the buyer
- Order confirmation or approval
- Production schedule and target calculation (Industrial engineering and production planning departments)

Key garment manufacturing steps (Cont…)

- **Pre-production activities** (pre-cutting, cutting and after cutting fabrics)
  - Production pattern making
  - Marker planning
  - Marker making
  - Fabric spreading
  - Fabric cutting
  - Sorting, bundling and stickering cut components
  - Value adding activities (embroidery, printing and fusing of cut components)

Key garment manufacturing steps (Cont…)

- **Sewing or assembly of components** (through a sequence of steps)
  - Selection of appropriate production systems (PBS, UPS, etc)
  - Planning the line and production targets for each workstation and operator
  - Balancing the manufacturing line
  - Inline and endline quality checking
- **Finishing:** pressing, other mechanical finishing
- **Packing:** preparation for shipment

Key garment manufacturing steps (Cont…)

- **Shipment:** manage the shipment based on shipping terms (FOB, CIF, and DDP)
  - Freight on Board (FOB): risk transfer occurs when goods leave the shipping port in supplier country
  - Cost, Insurance, and Freight (CIF): risk transfers after goods arrive at destination port
    - Seller pays insurance fee
  - Delivered Duty Paid(DDP): places maximum responsibility or risk on seller including customs clearance and duties

Departments in garment manufacturing process

Key functions or departments:

- Sampling
- Merchandizing
- Cutting
- Sewing
- Finishing
- Industrial engineering (IE)
- Quality control

Sampling department

Main activities

- Receiving order
- Fabric, accessories and trims development
- Fabric Lab dip preparation
- Sample pattern making
- Sample garment making
- Sample approval (prototype, fit, size set, and salesman's sample)
- Final pattern making (production pattern)
- Pattern grading

Merchandizing department

Main activities

- Mediate the factory with the buyer (internal and external communication) for export
- Garment sampling
- Fabric Lab dip development
- Accessories and trims sourcing
- Preparing production file (quality and production information for bulk production)
- Facilitate third party inspection
- Preparing of Bill of Material
- Production and shipment follow-up

Fabric department

Main activities

- Fabric purchasing (sourcing)
- Fabric inspection
- Fabric segregation by width and shade
- Fabric testing
- Issue fabric for cutting department

Cutting department

Main activities

- Fabric spreading (layering)
- Marker making
- Cutting the lay/spread fabric
- Sorting cut panels
- Ticketing and numbering of each layers
- Bundling and tagging
- Issue to sewing department

Sewing department

Main activities

- Receive fabric cut components form cutting department
- Receive bulk trims and accessories from store
- Style analysis
    - Plan sewing workflow , operation breakdown, sequence of assembly or work flow
    - Skill set of operators,
    - Machine type, setup and layout
- Assembly of garment parts
- Quality checking (within and end-of-the sewing line)
- Garment rework or repair

Finishing department

Main activities

- Issue and receive garment products
- Garment washing (optional for some products)
- Hard stain and spot cleaning
- Mechanical finishing (ironing, thread cutting, measurement checking, sticker removal etc.)
- Labels and tags attach, cartons labeling
- Folding and packing
- Shipment inspection

Industrial Engineering(IE) department

Main activities

- Product analysis and operation study
- Estimation of standard minute value (SMV) or standard allowed minute (SAM)
- Manpower and machine requirement planning
- Developing multi-skilled operators
- Reduce the training curve
- Line Balancing and production monitoring
- Sewing thread consumption

Cut order planning (COP)

- It is also called “lay plan” or “cut plan”
- Determines the arrangement or combination of markers and spread lays that can affect
    - Cost of garments and efficiency of the sewing line [1]
- Fabric cost covers about 70% of the garment cost
- Fabric cutting accounts for 5-10% of total manufacturing costs and 50-60% of material costs [2]
- Determine how to plan fabric cutting to fulfill garment orders
- Arrange garment sizes, styles, and colors for optimal fabric consumption
- Minimize fabric waste, cost, and operational complexity
- Ensures accurate and timely order fulfillment

Cut order planning procedures

- Analyze order breakdown (style, color, size):
  - Break down the total order by size (S, M, L, and XL); colors; Quantity per size-color combination
- Sort by fabric type/shade lot and shrinkage
- Plan size combinations for marker making
  - Combine multiple sizes in one marker (multi-size marker)
  - Choose marker width based on fabric and table constraints
- Estimate marker efficiency
  - Estimate how much fabric is used per garment in the marker
  - Target >85% efficiency

Cut order planning procedures

- Calculate garments per lay and number of lays
  - Based on fabric width, table length, and marker width
  - Number of plies (layers) is determined by the required garment quantity and marker size
- Develop a cut plan (number of plies or layers per lay)
  - Number of lays = Total garments ÷ Garments per lay
  - Adjust lay count to account for wastage and odd quantities
- Finalize marker plan and fabric allocation
  - Assign shade-wise rolls to each lay
  - Avoid shade mixing in a single lay

Requirements for cut order planning (COP)

- Sales order: style, color, size, quantity
- Fabric type, width, and availability
- Marker efficiency
- Table length
- Shrinkage, shade lot, and roll characteristics
- Cutting machine and table constraints

Cut order planning (COP)

Features of COP

- Cut order planning problem in the apparel industry is known to be an NP-Hard (nonlinear polynomial time) problem (Unal et al., 2020).
- Optimizes garment production costs by efficiently cutting fabric for garments
- Cut order planning may differ according to the objective preferred
  - Fabric utilization
  - Time efficiency
- Optimize the cutting operation under certain constraints & parameters
- Planning the purchase order to provide spreading and cutting instructions at the marker making stage

Cut order planning (COP)

Benefits of COP

- Low fabric cost (optimize the cutting process and reduce wastage)
- High efficiency (optimized use of cutting facilities)
- Improved resource allocation (align cut schedules with material availability and machine capacity)
- Optimize marker efficiency and fabric usage
- Ensure accurate quantity and shade matching
- Reduce the number of fabric lays and spreading
- Fulfill order requirements with minimal leftovers

Assembly line balancing (ALB)

- A product-oriented manufacturing process typically used for the mass production
- A set of distinct tasks assigned to workstations in a predefined sequence
- The workstations are connected by a transport mechanism in detailed assembling sequences
- It is the allocation of jobs to machines/ workstations in a uniform manner
- Assembly lines depends on work specialization
- Each workstation performs the same set of tasks on each product
- Efficiency of workers increase, minimize errors and maximize productivity

Assembly line balancing (ALB)

Requirements to design an assembly line system

- Precedence network of tasks
- Task times (deterministic or probabilistic)
- Cycle time
- Number of workstations

Assembly line balancing(ALB)

- Precedence network of tasks is an immediate precedence relationships among the tasks in product assembly
- Task time is either deterministic or probabilistic time required to execute each task
- Cycle time is the time between consecutive releases of the assemblies at the end of the line or the total time (maximum time) allocated to each workstation in the assembly line
- Number of workstations are number of machines engaged in different assembly operations

$$\text{Cycle time} = \frac{\text{Effective time available per shift}}{\text{Production voli=ume per shift}}$$

$$\text{Balancing efficiency} = \frac{\text{Sum of all task times}}{\text{Number of workstation}*\text{Cycle time}}*100$$

Assembly line balancing (ALB)

- Tasks are assigned to sewing machines in the workstations to perform in a balanced load
- Shop floor managers are concerned with the balance of the lines
- It is known as an NP-hard problem (difficult to solve and verify)
- Heuristic methodology can better plan the sewing lines within a reasonable time
- Algorithms are used to solve ALP problems at different labor skill levels and workload smoothing in the sewing workstations
  - E.g. genetic algorithms;

Types of assembly line balancing problems

Criteria to classify assembly line balancing problems are:

- Number of models (products) produced in the line
  - Single-model assembly system
  - Multi-model assembly system
- Nature of task times (deterministic or probabilistic)
- Nature of flow (straight-type or U-type)

Types of assembly line balancing problems

Classification based on the above criteria:

- Single-model deterministic straight-type (SM_D_S) problem –The simplest of all ALBP types
- Single-model deterministic U-type (SM_D_U) problem
- Single-model probabilistic straight-type (SM_P_S) problem
- Single-model probabilistic U-type (SM_P_U) problem
- Multi-model deterministic straight-type (MM_D_S) problem
- Multi-model deterministic U-type (MM_D_U) problem
- Multi-model probabilistic straight-type (MM_P_S) problem
- Multi-model probabilistic U-type (MM_P_U) problem

Types of assembly line balancing problems

Based on the objective of the optimization:

Assembly line balancing problems (ALBPs) can be divided into two main groups:

- Simple ALBP (SALBP)
- General ALBP (GALBP)

Simple assembly line balancing problem (SALBP)

- SALB-1- Minimize number of workstations/machines for a given cycle time (production rate)
  - Set up a new sewing line
- SALB-2- Minimize cycle time (Maximize production rate) for a given number of workstations/machines
  - Improve existing sewing line with fixed layout
- SALB-E- Maximize line efficiency (balance delay) for a given variable number of stations and cycle time
  - Both cost (stations) and throughput (cycle time) are flexible

Assumptions of SALBP

- Information is deterministic and known
- Tasks are elementary and should be performed at a single station
- Technological constraints impose a partial ordering among the tasks (certain tasks should be performed before others)
- All tasks should be processed in the line
- All stations are equally equipped

Assumptions of SALBP

- Task times are independent of the sequence or the workstation
- There are no constraints regarding which station performs a task, other than the technological constraints
- The assembly is performed in a one-sided straight line within a fixed allotted time-period for each workstation (known as the cycle time)
- The assembly line produces a single product

Assumptions of SALBP

- Order of tasks affect balancing efficiency (task to task relationship)
- Each work station characteristics is unique and affect efficiency of the line
- Resource constraint:
  - Resource shortage may limit number of workstations
- Cycle time constraints:
  - Single task cycle time shouldn't exceed total workstation's cycle time
- Worker allocation impact overall efficiency of the line

General assembly line balancing problem(GALBP)

- Stochastic task times
  - Task durations vary (e.g., due to manual work)
- U-shaped lines
  - Stations are arranged in a "U“ shape to allow cross-training and worker movement (more flexible than straight lines)
- Parallel workstations
  - Multiple stations performing the same task to alleviate bottlenecks
- Equipment or tooling constraints
  - Tasks cannot be assigned to a station without specific resources

Objectives of assembly line balancing problems

- Minimize the workflow among the operators
- Minimize work-in-progress (WIP)
- Reduce the throughput time (total time from start to finish a product assembly)
- Balance operator workload
- Maximize line efficiency
- Improve productivity and quality

Benefits of simulation in line balancing

Simulation of the sewing line helps to [3]:

- Identify bottlenecks in sewing process through process visualization
- Analyze process efficiency through Real time data on key metrics (rate of production, cycle times, and operator utilization)
- Reduce machine downtime through proactive measures
- Optimize worker utilization (data on worker performance, identifying skill gaps, and suggest training programs
- Cost-effectiveness

Summary

- Garment manufacturing process is characterized by:
    - Labor intensive processes
    - complex supply chain network
    - Stringent buyer requirements
    - Frequent change in demand
- Different functions or departments are involved from design to delivery of products
- Satisfaction of business and buyer requirements can be ensured through:
    - Optimization of resources in cutting (Cut order planning)
    - Optimization of resources in Sewing (Assembly line balancing)

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Thank You !

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