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The notes are based on the discussion in lectures for Manufacturing case study theory

key concepts related to production scheduling and manufacturing processes

1. Production Scheduling

- Definition: Production scheduling involves planning and organizing the manufacturing process to meet production targets. It specifies what needs to be produced, the quantity, and the timeline.
- Purpose: The goal is to ensure that production runs efficiently, meeting demand without overproducing or underutilizing resources.

3. Scrap and Quality Control

- Scrap: Material or parts that are rejected due to defects or quality issues. Scrap rates affect production planning, as not all produced items will be usable.
- Standard Scrap Rate: A predetermined percentage of production that is expected to be scrapped due to defects.
- Quality Control: Inspections are performed to ensure products meet quality standards, and defective products are discarded.

4. Loading and Capacity Planning

- Loading: Assigning production tasks to specific workstations over a defined period. It involves determining how much work each machine or workstation can handle.
- Capacity Planning: Ensuring that workstations have enough capacity to meet production goals while considering potential downtime for maintenance and changeovers.

5. Maintenance and Downtime

- Scheduled Maintenance: Regular maintenance activities are planned to prevent breakdowns, including cleaning, lubrication, and adjustments.
- Unplanned Downtime: Unexpected machine breakdowns or issues that disrupt the production schedule, leading to losses in production time and output.

6. Changeovers

- Definition: The process of switching a machine or workstation from producing one product to another. Changeovers often involve adjusting settings, cleaning, and testing to ensure the new production run meets quality standards.
- Impact on Production: Changeovers can lead to downtime, so they are strategically planned to minimize their impact on overall production.

7. Actual vs. Planned Production

- Planned Production: The intended production output based on the schedule.
- Actual Production: The real output achieved, which may differ from the plan due to factors like machine breakdowns, scrap, or worker errors.

- Analysis of Variances: Understanding the differences between planned and actual production helps in identifying issues and improving future schedules.

9. Shift Planning

- Shift Scheduling: Allocating production tasks to specific shifts (e.g., morning, evening) to optimize machine usage and meet production targets.

10. Multi-Product Scheduling

- Alternate Production Weeks: Machines are often scheduled to produce different products in alternate weeks to optimize utilization and meet varied production demands.

1. Overall Equipment Effectiveness (OEE)

- **Definition**: OEE is a metric used to measure the efficiency and effectiveness of a manufacturing process. It considers three primary factors: availability, performance, and quality.
- **Purpose**: The goal of OEE is to provide insights into how well equipment is utilized in production, identifying areas for improvement.

2. Factors of OEE

- **Availability**:
  - **Definition**: Measures the proportion of scheduled time that the equipment is available for production.
  - Calculation: $\text{Availability} = \frac{\text{Scheduled Production Time} - \text{Downtime}}{\text{Scheduled Production Time}}$
  - **Application**: In the conversation, availability is considered based on the number of shifts, with planned maintenance and changeovers excluded from the scheduled time. Unplanned downtimes, such as breakdowns, are factored in.
- **Performance**:
  - **Definition**: Evaluates how well the equipment performs compared to its maximum potential speed.
  - Calculation: $\text{Performance} = \frac{\text{Actual Output}}{\text{Standard Output}}$
  - **Application**: Performance is calculated as the ratio of actual production to the planned production, aggregated weekly. It's important to note that the output at the end of a production line (e.g., broaching) is used for this metric.
- **Quality**:
  - **Definition**: Measures the proportion of good units produced versus the total units produced.
  - **Calculation**: $\text{Quality} = \frac{\text{Good Units}}{\text{Total Units Produced}}$

- **Application**: Quality is determined by comparing the output with the acceptable standard, factoring in the scrap rate. This ensures only quality products are counted in the effective output.

3. Calculating OEE

- Formula: $\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality}$
- **Interpretation**: The product of the three percentages (availability, performance, quality) gives the overall effectiveness of the equipment. In practice, achieving 100% OEE is nearly impossible due to various operational challenges, so values like 72% are considered good in many industries.

4. Challenges in OEE

- **Interdependencies**: The conversation highlights the interdependence between different stages of production. For example, a delay in one stage (e.g., hobbing) can affect the subsequent stages (e.g., broaching).
- **Maintenance and Downtime**: Proper scheduling of preventive maintenance is crucial to minimize unplanned downtime, which directly impacts availability.
- **Quality Control**: Managing scrap rates and ensuring that production meets quality standards is essential for maintaining high OEE.

5. Practical Application

- **Weekly Analysis**: The participants discuss analyzing OEE on a weekly basis to understand trends and identify issues that may arise over different shifts.
- **Data Utilization**: The discussion implies using actual data from the production process to calculate OEE, which provides actionable insights for improving operations.

Cost Breakdown and Profitability Analysis:

1. **Cost Components:**
    - **Direct Materials:** These are the raw materials used in producing the gear assemblies. Each product, like gear assembly 3, has specific direct materials costs associated with it, derived from the cost of blanks required.
    - **Direct Labor:** Costs related to the workforce directly involved in producing the gear assemblies. This includes salaries, benefits, and overtime for workers on specific production lines.
    - **Production Overhead:** Indirect costs such as factory maintenance, utilities (e.g., lighting, air conditioning), and supervisor salaries that cannot be directly traced to a specific product but are necessary for overall production.
    - **General and Administrative Overhead:** Costs incurred outside the factory, including management salaries, office expenses, and other administrative costs.
2. **Margin Calculation:**
    - The **Cost of Goods Sold (COGS)** is calculated as the sum of direct materials, direct labor, and production overhead.

- The **Gross Margin** is obtained by subtracting the COGS from the sales price of each product. This helps identify which products are more profitable.

Inventory Management:

1. **Order Quantity and Inventory Levels:**
   - **Order Quantity:** The amount of each blank that needs to be ordered to meet production requirements. Orders are placed to ensure that there is enough stock to cover the demand.
   - **Ending Inventory:** The amount of stock remaining at the end of each month. This affects how much needs to be ordered to maintain production schedules.
2. **Safety Stock and Reorder Point:**
   - **Safety Stock:** Extra inventory held to account for variability in demand or supply delays, ensuring that production can continue smoothly even if unexpected issues arise.
   - **Reorder Point:** The inventory level at which a new order should be placed. This is calculated based on safety stock and lead time demand to prevent stockouts.
3. **Lead Time Demand:**
   - The amount of inventory needed to cover the period between placing an order and receiving it. This ensures that production can continue without interruption during the lead time.

Practical Implications:

1. **Profitability Decisions:**
   - By analyzing the gross margin of each product, businesses can identify which products generate the highest profit margins and prioritize their production accordingly.
   - Decisions on which products to focus on should consider both the profitability and the capacity constraints of the factory.
2. **Inventory Optimization:**
   - Using safety stock and reorder points helps prevent stockouts and ensures smooth production flow.
   - Balancing inventory levels avoids both excess stock, which ties up capital, and stockouts, which can halt production.
3. **Reorder Quantity Formula:**
   - The reorder quantity is determined using safety stock and lead time demand to balance inventory levels, ensuring neither excess nor insufficient stock.

1. ABC Classification

Concept: ABC Classification is a method used to prioritize inventory management based on the value and importance of items. It categorizes items into three groups (A, B, and C) to optimize inventory control efforts and resource allocation.

Categories:

- **A Category (High-Value Items)**:

    - **Characteristics**: High monetary value, significant capital investment.
    - **Management Focus**: Requires strict control and monitoring due to high cost and importance. Emphasizes Just-In-Time (JIT) purchasing to avoid tying up capital in inventory.
    - **Examples**: Expensive electronic devices like mobile phones.
- **B Category (Moderate-Value Items)**:
    - **Characteristics**: Moderate monetary value.
    - **Management Focus**: Requires good record-keeping and structured ordering. Less critical than A items but still important for operational efficiency.
    - **Examples**: Mid-range components or materials with moderate cost.
- **C Category (Low-Value Items)**:
    - **Characteristics**: Low monetary value, often ordered in bulk.
    - **Management Focus**: Minimal control required. Bulk purchasing is preferred to reduce ordering costs and benefit from economies of scale.
    - **Examples**: Groceries, low-cost consumables.

Theory on Safety Stock and Reordering

1. Safety Stock

Definition: Safety stock is the additional inventory kept to prevent stockouts caused by variability in demand or lead time. It acts as a buffer to ensure that there is enough inventory on hand to handle unexpected spikes in demand or delays in supply.

Purpose:

- To avoid stockouts when actual demand exceeds the forecasted demand.
- To cover for delays in the supply chain.

Calculation:

- **Reorder Point**: The reorder point is the inventory level at which a new order should be placed. It is calculated based on the average demand during the lead time (the time it takes to receive a new order).

Formula:

$$\text{Reorder Point} = \text{Average Demand during Lead Time}$$
$$\text{Reorder Point} = (\text{Average Daily Demand} \times \text{Lead Time in Days})$$

Safety Stock: Safety stock is the extra inventory kept to handle fluctuations in demand. It is calculated as the difference between the peak demand and the average demand.

Formula:

$$\text{Safety Stock} = (\text{Peak Demand per Day} - \text{Average Daily Demand}) \times \text{Number of Days for Safety Stock}$$

2. Reorder Point and Safety Stock Calculation

Reorder Point: The reorder point is set to ensure that new inventory arrives before the current stock runs out.

Safety Stock:

- **Average Demand**: The expected demand for the product over a period.
- **Peak Demand**: The highest demand expected during the lead time.
- **Safety Stock Calculation**: Calculate the difference between the peak demand and average demand to determine the additional stock needed to cover fluctuations.

Example Calculation:

1. **Lead Time**: 3 days
2. **Average Daily Consumption**: 10 units
3. **Peak Daily Consumption**: 12 units

- Reorder Point:
  $$\text{Reorder Point} = \text{Average Daily Consumption} \times \text{Lead Time}$$
  $$\text{Reorder Point} = 10\,\text{units/day} \times 3\,\text{days} = 30\,\text{units}$$
- Safety Stock:
  $$\text{Safety Stock} = (\text{Peak Daily Consumption} - \text{Average Daily Consumption}) \times \text{Lead Time}$$
  $$\text{Safety Stock} = (12\,\text{units} - 10\,\text{units}) \times 3\,\text{days} = 2\,\text{units/day} \times 3\,\text{days} = 6\,\text{units}$$
- Total Reorder Point:
  $$\text{Total Reorder Point} = \text{Reorder Point} + \text{Safety Stock}$$
  $$\text{Total Reorder Point} = 30\,\text{units} + 6\,\text{units} = 36\,\text{units}$$

3. Ordering Process

When Stock Hits Reorder Point:

- Place an order for the quantity required to bring inventory back up to a desired level. This reorder quantity typically includes the safety stock.

Safety Stock:

- Ensures that operations can continue smoothly even if there are delays or sudden increases in demand. The safety stock level acts as a buffer, so inventory levels might temporarily dip below the safety stock but should not reach zero if managed correctly.

Inventory Analysis

- **Inventory Management Basics:** Understanding the starting inventory, outstanding orders, and production quantities is essential for managing inventory efficiently. Inventory levels affect decisions on reordering and production scheduling.

2. **Monthly Data Handling**
   - **Ending Inventory Calculation:**
     - Formula: $\text{Ending Inventory} = \text{Starting Inventory} - \text{Production Issues} + \text{Order Received}$

- **Concept:** This formula helps calculate how inventory levels change over time based on production issues and orders. It reflects the inventory flow and helps in forecasting future needs.

Understanding the OFFSET Function

The OFFSET function is a powerful tool in Excel that allows you to create dynamic ranges and reference cells based on a starting point. This is particularly useful for creating flexible formulas and charts that adjust automatically when the data changes.

=OFFSET(reference, rows, cols, [height], [width])

- **reference**: The starting point of the reference (usually a cell or range).
- **rows**: The number of rows to move from the starting point. Positive numbers move down, and negative numbers move up.
- **cols**: The number of columns to move from the starting point. Positive numbers move right, and negative numbers move left.
- **height** (optional): The number of rows to include in the returned range.
- **width** (optional): The number of columns to include in the returned range.

Examples

1. **Basic Example**

Formula: =OFFSET(B2, 2, 3)

- **Reference:** B2
- **Rows:** Move 2 rows down
- **Cols:** Move 3 columns to the right

This formula refers to the cell E4 (2 rows down from B2 and 3 columns to the right).

2. **Dynamic Range for a Chart**

Suppose you have a dataset that grows over time, and you want your chart to automatically update to include new data. You can use OFFSET with the COUNTA function to create a dynamic named range.

Step-by-Step:

- **Create a Named Range:**
  - Go to the **Formulas** tab and click **Name Manager**.
  - Click **New** and enter a name for your range (e.g., DynamicRange).
  - In the **Refers to** box, enter the formula using OFFSET and COUNTA.

Example:

=OFFSET(A1, 0, 0, COUNTA($A:$A), 1)

- **A1**: Starting point of the range.
- **0, 0**: No offset from the starting point.

        - **COUNTA($A:$A)**: Number of rows in the range (counts non-empty cells in column A).
        - **1**: Number of columns in the range.
    - **Use the Named Range in a Chart:**
        - Create a chart and select **Select Data**.
        - In the **Chart Data Range**, enter the named range (e.g., DynamicRange).

As you add more data to column A, the chart will automatically update to include the new data.

3. **Creating a Dynamic Range with Height and Width**

Formula: OFFSET(A1, 0, 0, 5, 3)

- **Reference:** A1
- **Rows:** 0 (start at A1)
- **Cols:** 0 (start at column A)
- **Height:** 5 rows
- **Width:** 3 columns

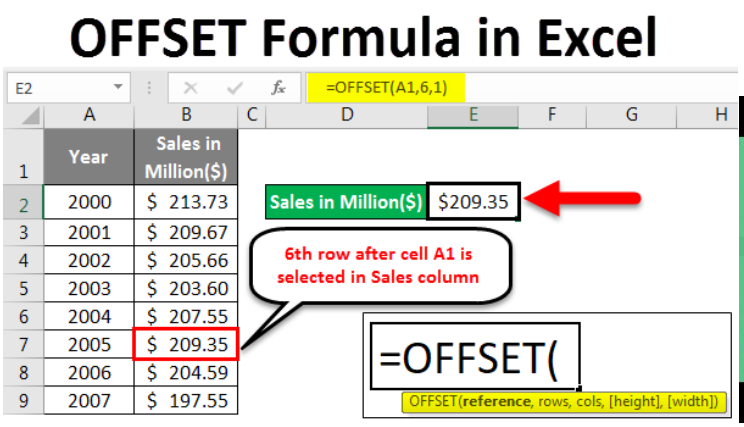
This formula refers to a range starting from A1 and extends 5 rows down and 3 columns wide (A1).

Common Use Cases for OFFSET

1. **Dynamic Charts:** Automatically adjust chart ranges as new data is added.
2. **Dynamic Named Ranges:** Use in formulas to reference changing data ranges.
3. **Flexible Data Extraction:** Create dynamic reports or summaries.

Important Considerations

- **Volatile Function:** OFFSET is a volatile function, meaning it recalculates every time the worksheet changes, which can affect performance with large datasets.
- **Use with Caution:** Overuse of OFFSET in complex worksheets can make troubleshooting difficult.



Still confused??? Have a look at this 5 min

Key Concepts and Theories

1. Inventory Management:

- **Production Issues:** Represents the amount of raw material issued to production each month. This fluctuates based on production needs.
- **Order Quantity:** The amount of raw material ordered when inventory falls below a specific threshold (reorder point). Common quantities are the reorder amount (e.g., 8,000 units) or higher if necessary.
- **Reorder Point:** The inventory level at which a new order is placed. It includes safety stock and lead time demand.
- **Safety Stock:** Buffer stock kept to account for variability in demand and supply delays. Calculated as the difference between the highest and lowest consumption months.
- **Lead Time Demand:** The average demand during the lead time (time taken for new stock to arrive). In this case, it is calculated based on historical data.

2. Inventory Analysis:

- **Smoothening:** Refers to the process of averaging or smoothing out fluctuations in the data to observe trends more clearly.
- **Ending Inventory:** The stock remaining after accounting for production issues and orders. This can be tracked over time to understand inventory levels and manage excess or shortage.

3. Graphical Representation:

- **Production Issues vs. Order Quantity:** A chart displaying the fluctuation in production issues (blue line) and corresponding order quantities (e.g., 8,000 or 16,000 units) helps visualize inventory management performance.
- **Inventory vs. Production:** An inverse correlation often exists between production levels and ending inventory. When production is high, inventory levels drop, and vice versa.

Excel Tools and Techniques

1. Data Visualization:

- **Charts and Graphs:** Use line charts to show fluctuations in production issues and order quantities. Pie charts can be used to visualize proportions of total orders or inventory levels.
- **Dynamic Charts:** Incorporate named ranges and OFFSET function to make charts update automatically as data changes.

2. Named Ranges and OFFSET:

- **Named Ranges:** Create dynamic named ranges using OFFSET to automatically adjust the range of data used in charts or formulas.
- **OFFSET Function:** Helps in defining ranges dynamically based on certain criteria. For example, use OFFSET to track changes in production and inventory levels over time.

3. Formulas and Functions:

- **IF Function:** Determine whether inventory levels fall below the reorder point and trigger an order.

- **AVERAGE Function:** Calculate the average demand during the lead time to set the reorder point.
- **COUNTIF and SUMIF Functions:** Aggregate data based on conditions, such as total orders placed in a given period.

4. Data Analysis:

- **Smoothing Techniques:** Apply moving averages or other smoothing techniques to the data to analyze trends and patterns.
- **Trend Analysis:** Use historical data to predict future inventory needs and adjust reorder points accordingly.