Industrial Engineering Cheatsheet

A concise reference for Industrial Engineering principles, methodologies, and tools. This cheatsheet covers topics from work measurement and process improvement to supply chain management and quality control.

Work Measurement and Methods Engineering

Time Study

Definition	Technique for determining the time required by a qualified worker to perform a task at a defined level of performance.
Steps	1. Select the job. 2. Record details. 3. Break down task into elements. 4. Measure time. 5. Rate performance. 6. Calculate normal time. 7. Determine allowances. 8. Calculate standard time.
Normal Time	Observed Time × Performance Rating Factor
Standard Time	Normal Time × (1 + Allowance Factor)
Performance Rating	Subjective assessment of worker's pace relative to standard pace (100%).
Allowances	Extra time given to workers to compensate for fatigue, personal needs, and unavoidable delays.

Motion Study

Definition	Analysis of the basic motions involved in performing an operation.
Principles of Motion Economy	Reduce number of motions, use simultaneous motions, use symmetrical motions, minimize distance, use momentum, arrange tools and materials for best sequence.
Therbligs	Basic elemental motions used in motion study (e.g., reach, grasp, move, release).
Micromotion Study	Detailed motion study using video recording and frame-by-frame analysis.
SIMO Chart	Simultaneous Motion Chart; used to record and analyze the simultaneous motions of two hands or other body parts.
Workplace Layout	Optimizing arrangement of tools, equipment, and materials to minimize worker movement and improve efficiency.

Work Sampling

Definition	Statistical technique used to determine the proportion of time spent by workers in various defined categories of activity.
Steps	1. Define activities. 2. Estimate percentage occurrence. 3. Determine desired accuracy. 4. Calculate number of observations. 5. Schedule observations. 6. Make observations. 7. Analyze data.
Number of Observations (N)	N = (z^2 * p * (1-p)) / E^2, where: • `z` = z-score for desired confidence level • `p` = estimated proportion of activity • `E` = acceptable error
Confidence Level	Probability that the true proportion lies within the confidence interval. Common values: 90%, 95%, 99%.
Random Observations	Observations must be taken at random times to ensure unbiased data.
Applications	Determining machine utilization, estimating allowance factors, analyzing work patterns.

Facility Layout and Material Handling

Types of Layout

Product Layout	Arrangement based on the sequence of operations for a specific product (e.g., assembly line).
Process Layout	Arrangement based on grouping similar machines or functions together (e.g., machine shop).
Fixed-Position Layout	Product remains in a fixed location, and workers and equipment are brought to it (e.g., shipbuilding).
Cellular Layout	Grouping dissimilar machines into cells to process families of parts with similar processing requirements.
Hybrid Layout	Combination of different layout types to optimize specific objectives.
Layout Selection	Depends on product variety, volume, and processing requirements.

Material Handling Principles

Gravity	Use gravity to move materials whenever possible (e.g., chutes, conveyors).
Unit Load	Handle materials in large unit loads to reduce the number of trips.
Mechanization	Use mechanical equipment to reduce manual handling.
Automation	Use automated systems to improve efficiency and reduce labor costs.
Standardization	Use standardized containers and equipment.
Ergonomics	Design material handling systems to minimize worker strain and injury.

Material Handling Equipment

Conveyors	Belt conveyors, roller conveyors, overhead conveyors.
Industrial Trucks	Forklifts, pallet trucks, AGVs (Automated Guided Vehicles).
Cranes and Hoists	Overhead cranes, jib cranes, chain hoists.
Automated Storage and Retrieval Systems (AS/RS)	Automated systems for storing and retrieving materials.
Robotics	Robots for material handling tasks.
Selection Criteria	Distance, volume, frequency, and type of material.

Quality Control and Management

Statistical Process Control (SPC)

Definition	Use of statistical techniques to monitor and control a process.
Control Charts	Graphs used to monitor process stability over time (e.g., X-bar chart, R chart).
X-bar Chart	Monitors the average of samples.
R Chart	Monitors the range (variability) of samples.
Control Limits	Upper Control Limit (UCL) and Lower Control Limit (LCL) define the acceptable range of variation.
Process Capability	Measure of how well a process meets specifications.
Cp (Capability Index)	$Cp = (USL - LSL) / (6 * \sigma)$
Cpk (Capability Index)	$Cpk = \min[(USL - \mu) / (3 * \sigma), (\mu - LSL) / (3 * \sigma)]$

Acceptance Sampling

Definition	Statistical method used to determine whether to accept or reject a batch of products based on a sample.
AQL (Acceptable Quality Level)	Maximum percentage of defective items that is considered acceptable.
LTPD (Lot Tolerance Percent Defective)	Maximum percentage of defective items that is considered unacceptable.
Producer's Risk (α)	Probability of rejecting a good lot.
Consumer's Risk (β)	Probability of accepting a bad lot.
Operating Characteristic (OC) Curve	Graph showing the probability of accepting a lot versus the lot fraction defective.

Quality Management Systems

ISO 9000	International standard for quality management systems.
Six Sigma	Methodology for reducing defects and improving process performance.
Lean Manufacturing	Systematic method for eliminating waste and improving efficiency.
Total Quality Management (TQM)	Management approach focused on continuous improvement and customer satisfaction.
DMAIC	Define, Measure, Analyze, Improve, Control; Six Sigma improvement cycle.
PDCA	Plan, Do, Check, Act; iterative improvement cycle.

Supply Chain Management

Inventory Management

EOQ (Economic Order Quantity)	Optimal order quantity that minimizes total inventory costs. $EOQ = \sqrt{(2DS)/H}$ Where: • D = Annual demand • S = Ordering cost • H = Holding cost per unit per year
Reorder Point	Inventory level at which a new order should be placed. Reorder Point = Lead Time Demand + Safety Stock
Safety Stock	Extra inventory held to protect against stockouts due to variability in demand or lead time.
ABC Analysis	Inventory categorization method based on value and importance (A items: high value, C items: low value).
Just-in-Time (JIT)	Inventory management system focused on minimizing inventory levels by receiving materials just when they are needed.
Inventory Turnover	Measure of how many times inventory is sold or used in a period. Inventory Turnover = Cost of Goods Sold / Average Inventory

Forecasting

Moving Average	Forecast based on the average of past data points over a specific period.
Weighted Moving Average	Forecast based on the weighted average of past data points.
Exponential Smoothing	Forecast that uses a smoothing constant to weight recent data more heavily. $F_{t+1} = \alpha A_t + (1-\alpha)F_t$ Where: • α = Smoothing constant • A = Actual demand • F = Forecasted demand
Regression Analysis	Statistical method for predicting future values based on the relationship between variables.
Forecast Error	Difference between the actual demand and the forecasted demand.
Mean Absolute Deviation (MAD)	Average absolute difference between actual and forecasted values. $MAD = \Sigma\lvert Actual - Forecast\rvert / n$

Logistics and Distribution

Transportation Modes	Truck, rail, air, water, pipeline.
Warehousing	Storage of goods before distribution.
Distribution Centers	Facilities for receiving, storing, and shipping goods.
Cross-Docking	Process of receiving goods and immediately shipping them without storage.
Third-Party Logistics (3PL)	Outsourcing logistics functions to a third-party provider.
Reverse Logistics	Managing the flow of returned goods.