



The Shirpur Education Society's

**R. C. Patel College of Engineering and
Polytechnic, Shirpur**

Department of Mechanical Engineering

NAME OF COURSE: - Emerging Trends in Mech Engg

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SEMESTER: - ME-5K (TYME)

**Unit - 2 Recent trends in Mfg systems
16 Marks**

SUBJECT TEACHER

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Unit 2 - Recent trends in manufacturing systems.

2.1) Big data in manufacturing =

Collection of information during manufacturing from sources like machines, sensors, production process, employees, supply chain logistics & customer feedback refers to as Big data in mfg.

By analysing big data in mfg, manufacturer can -

- i) Improve operational efficiency.
- ii) Predict failure of machines, equipments using predictive maintenance tools.
- iii) Optimize supply chain.
- iv) Improve quality of product by making real time adjustment in production process/design of product.
- v) Help to improve productivity.

With industry 4.0, manufacturers has more tools & recent technologies & data to take better decisions. By analysing the data manufacturer can identify the customer needs, accordingly solve the problems by improving production process.

It is beneficial for all mfg companies to compete with adversity and growing industry in future.

Big data characteristics =

1) Volume = Huge data collected every second during manufacturing refers to as Volume. Data includes -

i) Sensor data = Sensors continuously collect the data from machines like temperature, vibration, pressure, & sound readings.

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ii) Historical data = For future analysis purpose, manufacturer must need to store collected data in safe environment.

iii) Data management = It is important for any manufacturer to use technologies such as Hadoop, distributed computing systems to handle very large datasets.

2) Velocity = The speed with which the data generated, transferred & processed termed as velocity.

i) Real time analysis = The data analysed during ~~the~~ production can be analyse to detect any abnormalities or problems. ~~during~~

ii) Edge computing = Smart devices can employed to process data quickly to identify fault & to prevent machine failure.

iii) Supply chain management = The data regarding availability of raw material help companies to take decision for material procurement through supply chain management.

iv) Automated testing = From image processing or any other non-destructive testing, ~~it makes very~~ simple by using computing one can identify defective parts quickly.

3) Variety = The various types & formats of data generated during mfg referred to as Variety. Data includes -

i) Structured ~~and~~ data = The data stored as tables and ~~at~~ database in well organized manner. Such as sensor data, production quantities etc..

ii) Semi structured data = Data such as XML files, JSON data ~~generated~~ & system logs generated by IoT devices.

4) Veracity = Veracity means the accuracy, quality and reliability of data collected during mfg.

i) Sensor errors = Errors from faulty sensor can reduce the accuracy of the production. Hence, it is very important to identify faulty sensor & replacing it.

ii) Missing data = Data may be lost during its transfer by networks for any communication failures.

iii) Data validation = Sophisticated softwares are used to validate the data to ensure the collected data is correct & reliable.

iv) Accuracy = Incorrect data can lead to take wrong decisions, so accuracy must be needed.

5) Value = Useful benefits gain by mfg companies by analysing large data is known as value.

It help to predict machine failure through predictive maintenance. Improvement in production by proper utilization of resources.

Benefits of big data in mfg =

1) Predictive maintenance = Big data can analyse & predict machine failure before they happens. This will reduce unexpected breakdowns, its cost for major ~~fail~~ failures.

2) Improved product quality = Identification of defective production is very easy using big data and its analysis. It will identify defects at early stages, which improves production quality.

3) Higher productivity = Reduction in downtime, improvement in production process, reduction in delays, increase in ~~no~~ flawless production can leads to improve productivity.

4) Reduction in cost = Analysing big dataset can help to reduce rejection in production, rework, reduction in energy consumption, reduction in maintenance & reduction in production cost.

5) Enhanced decision making = Real time data supports to planning & making strategic decisions. It increase the accuracy & improve productivity.

6) Customer satisfaction = Big data can help to understand the problem, need of customer. Helps to understand customer preference. Analysing big data help to provide solution for customers communication problems & one to one solution for their problems.

7) Energy utilisation & management = Energy ^{management} utilisation in mfg industry can help to reduce energy consumption & improves sustainability goals.

2.2) Data analytics in manufacturing =

Introduction =

Analysing big data is big task for mfg industries to understand information, take better decisions & increase profits. Advanced tools helps mfg industry to collect, validate, analyse & effective use of large data.

To survive in rapidly changing global market, manufacturers use big data ~~an~~ analytics to improve in industries overall performance. AI & ML helps mfg. industries to manage & analyze data effectively to identify problems, improve quality & for making good decisions.

Steps in data analytics =

- 1) Identification of problem
- 2) Data collection
- 3) Data processing
- 4) Data analysis

5) Data visualization

6) Decision making

1) Identification of problem/Problem statement

Clearly defining any issue, objective arising by stakeholders before starting data analysis is 1st step in data analytics.

Problems may be related with product quality, high production cost, machine frequent breakdowns, excess power consumption, improper utilisation of raw material or delays in production. Clearly mentioned problem can help to collect right data, selecting suitable methods & finding suitable best solution.

2) Data collection = This step involves collection of data from sources like - Machine data, Production data, A.C. data, Inventory & supply chain, Process & utility data. Data collected by following methods like Auto. sensor networks, Direct mlc learning, Barcode scanning, Vision system by camera, or digital interfaces.

3) Data processing = In this step the collected, ~~unfiltered~~ data unorganised data, inaccurate, irrelevant records gets corrected & stored in proper manner.

In this step following steps are followed:

- i) Removing duplicates.
- ii) Fix structural errors.
- iii) Handling missing data.
- iv) Irrelevant data gets filtered.
- v) Outliers are managed.

Using above steps one can get benefits like, improved accuracy, quick processing, Better machine learning etc.

4) Data analysing = In this step the data collected during mfg. examined using statistical methods, software tools & machine learning techniques to identify patterns, trends & problems. It helps to improve product quality, reduction in cost, increased productivity & helping in making better decisions.

5) Data visualisation = Using data visualisation tools like charts, graphs, dashboards, tables etc the collected & analysed data can be represented. It helps to identify some fixed patterns, loop holes, problems in the data & helps to take correct decision in very short time period. Now a days python programming can be utilise to handle sum large data..

6) Decision making = In this final step the analysed data & results are processed to take appropriate action. It helps to improve in quality of product, reduction in cost of product & production, improvement in productivity, less machine breakdowns & improvement in overall efficiency.

Types of data analytics =
Data analytics mainly classified into four

- categories -
- i) Descriptive analytics
 - ii) Diagnostic analytics
 - iii) Predictive analytics
 - iv) Prescriptive analytics.

i) Descriptive analytics =

To understand past production performance, past manufacturing data is analyzed. The data related to machine downtime, defects, rejection rate, rework & energy consumption.

It is simple type of analytics & summarize large & complex data into easy & simple understandable formats like charts or graphs etc.

Steps in descriptive analytics =

- a) Defining the objective
- b) Data collection
- c) Data cleaning
- d) Data processing
- e) Data visualisation

Eg. - To find the no of defective products produced during last month.

It addresses to the question "What happened?"

i) Diagnostic analytics = Instead of finding what happened in past, this technique identifies the root cause of problem during manufacturing.

It can analyze the data like machine data, process parameters & production records. By taking corrective actions mfg company improves its productivity & improvement in efficiency.

- Steps =
- a) Identify problem
 - b) Compare data
 - c) Find relationships
 - d) Determine root cause

Eg. - finding out the cause behind overheating in any machine during production, cause for increase in defective production.

It addresses to the question "Why did it happen?"

iii) Predictive analytics =

By using historical big data, statistical methods & recent trends like machine learning techniques, the future events ~~is~~ might be predicted like machine failure, product demand, maintenance schedule, productivity & production performance.

Steps =

- a) Collection of data.
- b) Prepare data.
- c) Select proper model for prediction.
- d) Test model for accurate prediction.
- e) Make predictions.

Eg. a) Predictive maintenance.

b) Demand forecasting

c) Predict quality of production.

d) Inventory prediction.

It addresses to the question "What is likely to happen?"

iv) Prescriptive analytics =

This technique use historical data, predictions, optimize techniques & computer algorithms to find out optimal solution for any problem arises in manufacturing.

Steps =

- a) Defining objectives.
- b) Data collection & analysis.
- c) Data prediction.
- d) Identify possible actions.
- e) Identify alternatives.
- f) Select best alternative.
- g) Implementation & monitoring.

Eg. Suggestions regarding best possible production schedule, machine settings, maintenance schedule to reduce rejection and/or increasing productivity.

It addresses to the question - "What should be done?"

* Data analytics techniques =

1) Regression analysis = This technique use to study between input variables & ~~one~~ output variable. Input variable relates to mfg factors & op to production. This statistical technique use to predict outcomes &

improve production process.

Eg. To study how cutting speed, feed rate & depth of cut affect surface roughness during mfg. Results help to select proper parameters.

2) Monte carlo simulation in mfg =

Random values & repeated calculations are used in this method to predict possible outcome when there is uncertainty in mfg. Used in production planning, inventory management, risk analysis, quality control etc.

3) Factor analysis = This technique is used to identify the main factors that influence manufacturing performance from large no. of variables. This technique is employed to identify key quality factors, reduce the data, analyse defects, analyse performance etc.

4) Cohort analysis = This technique divides the data into groups i.e. cohorts having common features & compares their performance over time. Employed in product batch analysis, m/c performance analysis, employee performance analysis, supplier analysis, maintenance analysis & customer analysis.

5) Cluster analysis = This technique makes groups of similar machines, customers, products or mfg process. into cluster based on common characteristics. Use to group machines, defect classification, product grouping, predictive maintenance, process optimisation etc.

6) Time series analysis = This technique is used to analyse mfg data collected over time to detect fixed trends, patterns & can predict future values. Used to forecast production, demand prediction, predictive maintenance, quality monitoring, inventory planning, energy consumption.

7) Sentiment analysis = This technique used to analyse feedbacks, reviews, opinions & comments to determine whether the expressed sentiment is positive, -ve or neutral. It includes - Customer feedback analysis, Brands reputation analysis, employees analysis, Suppliers evaluation, etc

Applications of big data analytics in manufacturing =

1) Preventive maintenance =

Regular inspection, servicing, maintaining machines, & equipment before breakdown refers to preventive maintenance. Big data can be utilised to prevent unexpected machine failure. By collecting the data through sensors, monitoring m/c condition, detecting fault earlier, by proper maintenance ~~scheduling~~ scheduling etc.

eg. Increase in temperature, noise, vibrations may be indication of bearing failure. Sensing them m/c can be maintained before failure.

2) Product design = Engineers can identify product related issues & customer needs through analysing customer feedbacks, product performance, warranty claims, market trends & previous product data.

eg. Cars manufacturer improve his existing product by analysing customer complaints, suggestions, & vehicle performance to improve design of car for better performance.

3) Production management automation =

Mfg systems can adjust machine parameters, production schedule, & resource analysis by analysing real time data fetched from sensors, machines, robots & production lines etc.

uses of automation =

- i) Automatic material handling
- ii) Automated m/c like cars,
- iii) Use of robots in assembly,
- iv) Use of camera, sensor in qc.
- v) Use of robots in painting, welding.
- vi) Automation in packaging.

4) Customer experience = Customer input is very important for every business. Customer feedback collected from customers by various methods like surveys, complaints, feedback online, offline, & stored in one central location.

By analysing this data company can get insights from customers point of view, Company can identify customer needs, their purchase patterns. This technique improves communication & customer satisfaction.

5) Supply chain improvement = By adopting it companies can manage supply chain effectively. Big data related to suppliers, inventory, transportation & product delivery can be analysed. By analysing it manufacturers can identify problems, reduce cost & improve efficiency. Also tracking it at real time is very convenient. Real time data make help to make better decisions; improves relations with suppliers, timely delivery of products etc.

Benefits =

1) Competitive advantage = Big data provide good understanding to manufacturers regarding market requirement, customer need & machine performance, enabling quick decisions & better competition.

2) Innovation = Data analytics can motivate industries to develop new concepts, designs, product, process to survive in today's competitive market. New innovations also increase the reputation of company which increase the brand value. Also new business ideas can be discovered.

3) Cost effective = Through predictive maintenance, better inventory management, accurate forecasting, automation, better supply chain management company can be able to save much more cost.

4) Improvement in customer satisfaction =

Big data analytics can provide better view regarding customer's need & their requirement. By analysing the data & other information regarding customer needs company can make better decisions. It improves product design, quality, supply chain, management & risk assessment. In Industry 4.0 big data analytics increases productivity, reduces operational problems & helps mfg. remain competitive.

2.3) Data analytics in quality control =

Introduction =

The process of collecting the data, analyzing it & interpreting production data to maintain & improve quality of product is termed as data analytics in quality control.

Manufacturers can monitor quality in real time using data analytics. This is continuous process of finding defects with their solutions, reduction in waste & rework & taking corrective measures. Techniques for it already explained.

Applications of data analytics in Quality control =

- 1) Predictive quality analysis = Data analytics employs historical data and uses machine learning algorithms to predict machine failure, defects, any other problems related to product quality before they appear. This helps to reduce downtime, expensive maintenance & product recalls.
- 2) Quicker quality checks = By use of automation in inspection & testing process this task of maintaining is made easy & quicker. It quickly identifies the defects, abnormalities in production & help to make proper corrective action.
- 3) Risk identification = Identification of abnormalities like increase in temperature, vibration, sound, pressure or any abnormal condition can be detected well before ~~misshappening~~ misshappening. like m/c failure, blast etc.
- 4) Solutions for quality improvement = Analytics not only identifies problems to quality but also give various optimal solution to get rid of it. All this ~~action~~ corrective actions can be carried out by analysing historical big data.
- 5) Finding root cause = Data analytics can help manufacturer to identify problems also it can find out the root cause of products defects & process failures.
- 6) Improvement in productivity = By optimising raw materials, machine performance, labour utilisation, production condition can effect on improvement in productivity, also by effective utilization waste is also reduced.
- 7) Automotive industry = Used to monitor vehicle components, prediction of m/c failure, reduces product recalls & improvement in vehicle reliability.

Benefits =

- 1) Efficiency improvement = Quality analysis - identifies lacunas & inefficient processes by analysing production time, machine utilisation, & workflow data. This helps to improve production speed & production efficiency.
- 2) Reduction in waste = By analyzing rejection, scrap & defective production data manufacturer can identify ~~the~~ the cause of waste & helps to take corrective action. This will reduce material wast & production cost.
- 3) Improvement in product quality = At initial stages problems, defects can be easily identified by use of data analytics in quality control. As per analysis of problem's company can take corrective action. It will improve overall efficiency & quality of production.
- 4) Customer satisfaction = By analyzing customer complaints, feedbacks, suggestions, & product return manufacturer can improve product & fulfill the requirement of customer.
- 5) Competitive advantage = It helps to understand market requirement, product demand & customer preferences. This enables manufacturing units to take better & quick decisions to be in competitions.
- 6) Reduction in defects = By using statistical tools to identify root cause of defective production companies can be able to reduce defective production. Corrective actions can be taken to improve the quality of production with very less defective production.
- 7) Improvement in production efficiency = Quality analysis helps to finding out problems in production, process, machine failure, delays in production. Manufacturing company can take necessary action like production rescheduling, manages workflow & increased production output.

8) Better decision making = Filtered accurate production data & quality data helps management to make better decisions on scheduling production, scheduling maintenance of machines, effective use of employees & improvement in manufacturing processes.

9) Increased profitability =

By reducing defects, rejects, rework, improvement in product quality, lowering production cost, reduction in waste, benefits to the manufacturers in increasing profitability & business growth.

