UNIT- IV FAULT TRACING

The fault Tracing concept helps to build up a concrete understanding of the cause and effect relationship for failure. This mechanism is that boost and prepares us for the survival point of time in the condition ofbreakdown.

This fault tracing helps to train the people and equipment with the dos and don'ts then. This helps to bringssustainability to the working structure and knowledge skillset.

IMPORTANCE

- It gives the skillset to cope with the situation of breakdown.
- It provides a flexible routine for working.
- It helps to save resources and life from the damage.
- It increases the reliability of the organization.
- It also helps to manage the financial risk of damage.

The Fault Tree Analysis strategy is a failure analysis. The option that uses deductive reasoning in order to discover the root cause of an issue. Once that root cause is found, it can then be resolved as quickly and efficiently as possible to help preserve quality.

FTA is most commonly used in engineering, safety, and manufacturing environments, though it can be applied to just about any situation. By looking at how a system can fail, Fault Tree Analysis is able to help determine what steps can be taken to reduce the risk of problems.

While Fault Tree Analysis can certainly be used to investigate a known issue, it is best for finding problemsbefore they occur. By creating a "tree" that looks at each area where there is potential for issues, companiescan take preventative action to either keep those problems from happening at all or reduce the impact of theissue should it occur. This is why FTA is such a popular option for high-risk environments where any type of problem could cause catastrophic issues.

Fault tree analysis (FTA) is a type of failure analysis in which an undesired state of a system is examined.This analysis method is mainly used in safety engineering and reliability engineering to understand how systems can fail, to identify the best ways to reduce risk and to determine (or get a feeling for) event rates ofa safety accident or a particular system level (functional) failure.

FTA is used in the aerospace, nuclear power, chemical and process, pharmaceutical, petrochemical and otherhigh-hazard industries; but is also used in fields as diverse as risk factor identification relating to social service system failure.

FTA is also used in software engineering for debugging purposes and is closely related to cause-eliminationtechnique used to detect bugs.

In aerospace, the more general term "system failure condition" is used for the "undesired state" / top event of the fault tree. These conditions are classified by the severity of their effects.

The most severe conditions require the most extensive fault tree analysis. These system failure conditions and their classification are often previously determined in the functional hazard analysis.

Fault tree analysis can be used to:

- understand the logic leading to the top event / undesired state.
- show compliance with the (input) system safety / reliability requirements.
- prioritize the contributors leading to the top event- creating the critical equipment/parts/events lists fordifferent importance measures
- monitor and control the safety performance of the complex system (e.g., is a particular aircraft safe to flywhen fuel valve *x* malfunctions? For how long is it allowed to fly with the valve malfunction?).
- minimize and optimize resources.
- assist in designing a system. The FTA can be used as a design tool that helps to create (output / lowerlevel) requirements.
- function as a diagnostic tool to identify and correct causes of the top event. It can help with the creationof diagnostic manuals / processes.

SEQUENCE OF FAULT FINDING ACTIVITIES

Steps involved in FTA:

1. Define the undesired event to study.

Definition of the undesired event can be very hard to catch, although some of the events are very easy and obvious to observe. An engineer with a wide knowledge of the design of the system or a system analyst withan engineering background is the best person who can help define and number the undesired events. Undesired events are used then to make the FTA, one event for one FTA; no two events will be used to makeone FTA.

2. Obtain an understanding of the system

Once the undesired event is selected, all causes with probabilities of affecting the undesired event of 0 or more are studied and analyzed. Getting exact numbers for the probabilities leading to the event is usually impossible for the reason that it may be very costly and time consuming to do so. Computer software is usedto study probabilities; this may lead to less costly system analysis. System analysts can help with understanding the overall system. System designers have full knowledge of the system and this knowledge is very important for not missing any cause affecting the undesired event. For the selected event all causes are then numbered and sequenced in the order of occurrence and then are used for the next step which is drawing or constructing the fault tree.

3. Construct the fault tree

After selecting the undesired event and having analyzed the system so that we know all the causing effects (and if possible, their probabilities) we can now construct the fault tree. Fault tree is based on AND and ORgates which define the major characteristics of the fault tree.

4. Evaluate the fault tree

After the fault tree has been assembled for a specific undesired event, it is evaluated and analyzed for any possible improvement or in other words study the risk management and find ways for system improvement.This step is as an introduction for the final step which will be to control the hazards identified. In short, in this step we identify all possible hazards affecting in a direct or indirect way the system.

5. Control the hazards identified

This step is very specific and differs largely from one system to another, but the main point will always be that after identifying the hazards all possible methods are pursued to decrease the probability of occurrence.

Fault tree analysis (FTA) is a top down, deductive failure analysis in which an undesired state of a system isanalyzed using Boolean logic to combine a series of lower-level events.

This analysis method is mainly used in the field of safety engineering and Reliability engineering to determine the probability of a safety accident or a particular system level (functional) failure. FTA can be used to:

- Understand the logic leading to the top event / undesired state.
- Show compliance with the (input) system safety / reliability requirements.
- Prioritize the contributors leading to the top event - Creating the Critical
- Equipment/Parts/Events lists for different importance measures.

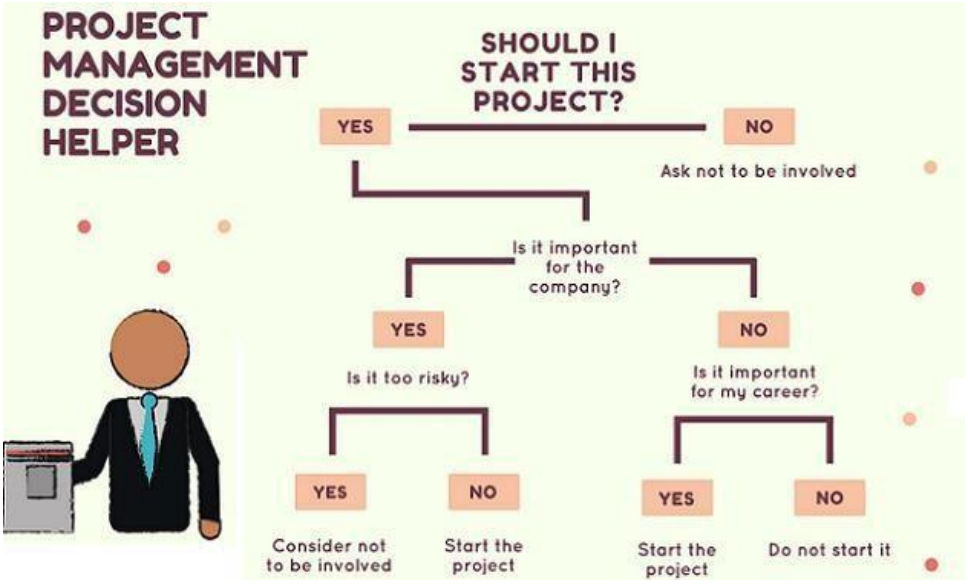
DECISION TREE CONCEPT

A decision tree is a support tool with a tree-like structure that models probable outcomes, cost of resources,utilities, and possible consequences. Decision trees provide a way to present algorithms with conditional control statements. They include branches that represent decision-making steps that can lead to a favorable result.

Decision trees are one of the best forms of learning algorithms based on various learning methods. They boost predictive models with accuracy, ease in interpretation, and stability. The tools are also effective in fitting non-linear relationships since they can solve data-fitting challenges, such as regression and classifications.

NEED AND APPLICATIONS

- Decision trees are used for handling non-linear data sets effectively.
- The decision tree tool is used in real life in many areas, such as engineering, civil planning, law, and business.
- Decision trees can be divided into two types; categorical variable and continuous variable decision trees.Imagine you are an IT project manager and you need to decide whether to start a particular project or not.You need to take into account important possible outcomes and consequences. The decision tree examples, in this case, might look like the diagram below.



TYPES OF DECISIONS

There are two main types of decision trees that are based on the target variable, i.e., categorical variable decision trees and continuous variable decision trees.

1. Categorical variable decision tree

A categorical variable decision tree includes categorical target variables that are divided into categories. Forexample, the categories can be yes or no. The categories mean that every stage of the decision process falls into one category, and there are no in-betweens.

2. Continuous variable decision tree

A continuous variable decision tree is a decision tree with a continuous target variable. For example, the income of an individual whose income is unknown can be predicted based on available information such astheir occupation, age, and other continuous variables.

APPLICATIONS OF DECISION TREES

1. Assessing prospective growth opportunities

One of the applications of decision trees involves evaluating prospective growth opportunities for businessesbased on historical data. Historical data on sales can be used in decision trees that may lead to making radicalchanges in the strategy of a business to help aid expansion and growth.

2. Using demographic data to find prospective clients

Another application of decision trees is in the use of demographic data to find prospective clients. They canhelp streamline a marketing budget and make informed decisions on the target market that the business is focused on. In the absence of decision trees, the business may spend its marketing market without a specificdemographic in mind, which will affect its overall revenues.

3. Serving as a support tool in several fields

Lenders also use decision trees to predict the probability of a customer defaulting on a loan by applying predictive model generation using the client's past data. The use of a decision tree support tool can help lenders evaluate a customer's creditworthiness to prevent losses.

Decision trees can also be used in operations research in planning logistics and strategic management. Theycan help in determining appropriate strategies that will help a company achieve its intended goals. Other fields where decision trees can be applied include engineering, education, law, business, healthcare, and finance.

ADVANTAGES OF DECISION TREES

1. Easy to read and interpret

One of the advantages of decision trees is that their outputs are easy to read and interpret without requiring statistical knowledge. For example, when using decision trees to present demographic information on customers, the marketing department staff can read and interpret the graphical representation of the data without requiring statistical knowledge.

The data can also generate important insights on the probabilities, costs, and alternatives to various strategiesformulated by the marketing department.

2. Easy to prepare

Compared to other decision techniques, decision trees take less effort for data preparation. However, users need to have ready information to create new variables with the power to predict the target variable. They can also create classifications of data without having to compute complex calculations. For complex situations, users can combine decision trees with other methods.

3. Less data cleaning required

Another advantage of decision trees is that there is less data cleaning required once the variables have beencreated. Cases of missing values and outliers have less significance on the decision tree's data.

***DISADVANTAGES OF DECISION TR*EES**

1. Unstable nature

One of the limitations of decision trees is that they are largely unstable compared to other decision predictors.A small change in the data can result in a major change in the structure of the decision tree, which can conveya different result from what users will get in a normal event. The resulting change in the outcome can be managed by machine learning algorithms, such as boosting and bagging.

2. Less effective in predicting the outcome of a continuous variable

In addition, decision trees are less effective in making predictions when the main goal is to predict the outcome of a continuous variable. This is because decision trees tend to lose information when categorizingvariables into multiple categories.

HOW TO DRAW A DECISION TREE?

To draw a decision tree, first pick a medium. You can draw it by hand on paper or a whiteboard, or you canuse special decision tree software. In either case, here are the steps to follow:

1. Start with the main decision. Draw a small box to represent this point, then draw a line from the box to theright for each possible solution or action. Label them accordingly.

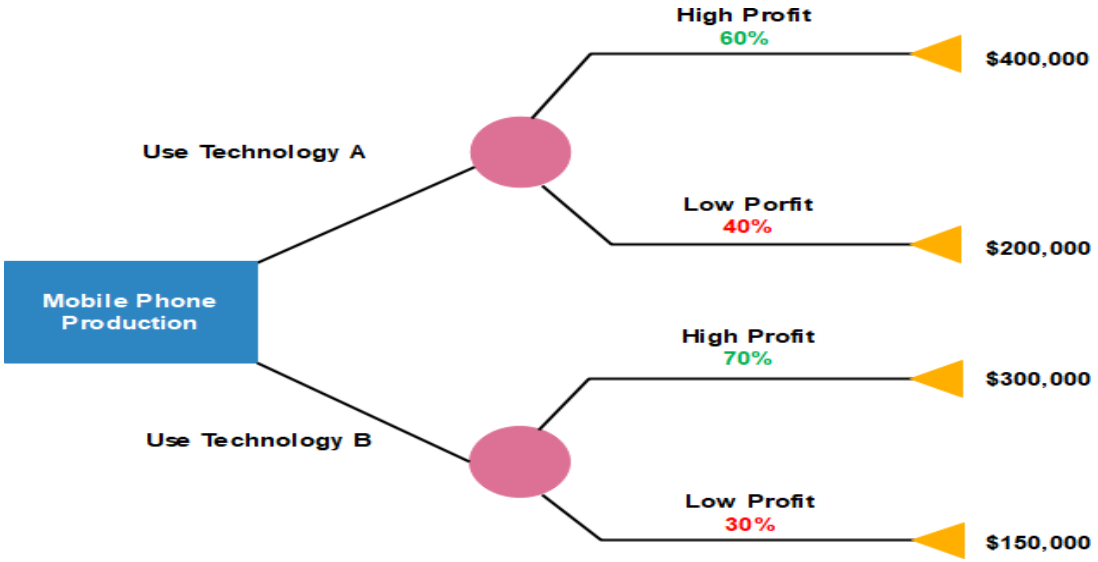
2. Add chance and decision nodes to expand the tree as follows:

- If another decision is necessary, draw another box.
- If the outcome is uncertain, draw a circle (circles represent chance nodes).

- If the problem is solved, leave it blank (for now).

From each decision node, draw possible solutions. From each chance node, draw lines representing possibleoutcomes. If you intend to analyze your options numerically, include the probability of each outcome and the cost of each action.

3. Continue to expand until every line reaches an endpoint, meaning that there are no more choices to be made or chance outcomes to consider. Then, assign a value to each possible outcome. It could be an abstractscore or a financial value. Add triangles to signify endpoints.



With a complete decision tree, you're now ready to begin analyzing the decision you face

DECISION TREE

Decision Tree is a holistic approach to equipment maintenance that strives to achieve perfect production (i.e. production without any breakdowns, small stops or slow running, defects and accidents)

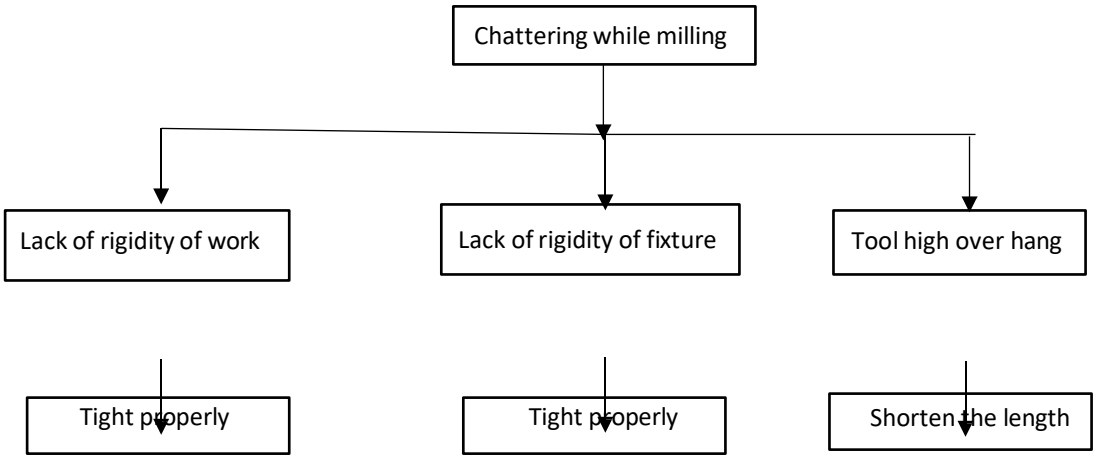
Decision Tree emphasizes proactive and preventive maintenance to maximize the operational efficiency of equipment.

DECISION TREE FOR PROBLEMS IN MACHINE TOOLS (CASE STUDY)

Decision Tree is a tool which is used for analyzing the risk and utilizing the equipment according the decisiontaken after analyzing the factors, causes and failure severity.

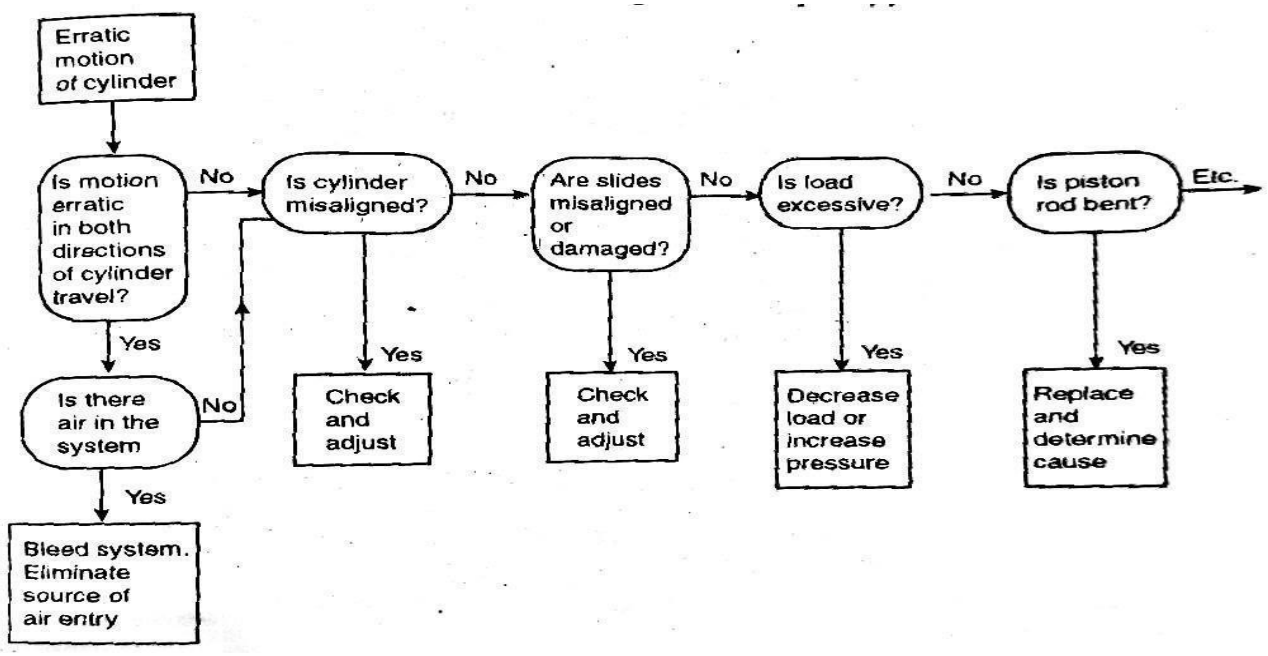
For Example: Chattering mark occurring on the surface of the work during operation of Milling in a surfacemilling machine. Decision tree if prepared and finding out the cause and prevention action will be taken.

The cost of the maintenance, time taking for repair, the increase the cost per peace after repairing the equipment are all analyzed through the decision tree and finally proper decision will be taken whether the machine tool can be repaired at that time or taking some other steps for the particular work.



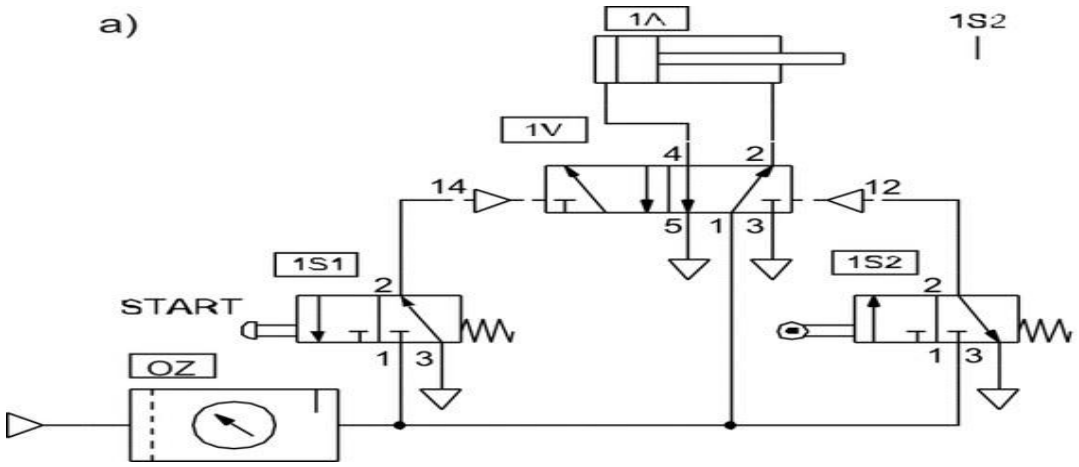
DECISION TREE FOR PROBLEMS IN PUMPS (CASE STUDY)

A hydraulic circuit can look very complex to the uninitiated and can make fault finding almost impossible. So it is easier for maintenance engineers to use charts to simplify troubleshooting. One such fault finding chart is called the Tree-branching chart. It asks a question which has only two possible answers 'yes' or 'no'.The answer determines the next step to be taken. It is said that on an average it takes four times as long to locate a fault as it does to rectify it. This technique helps develop a logical and rapid approach to fault diagnosis.



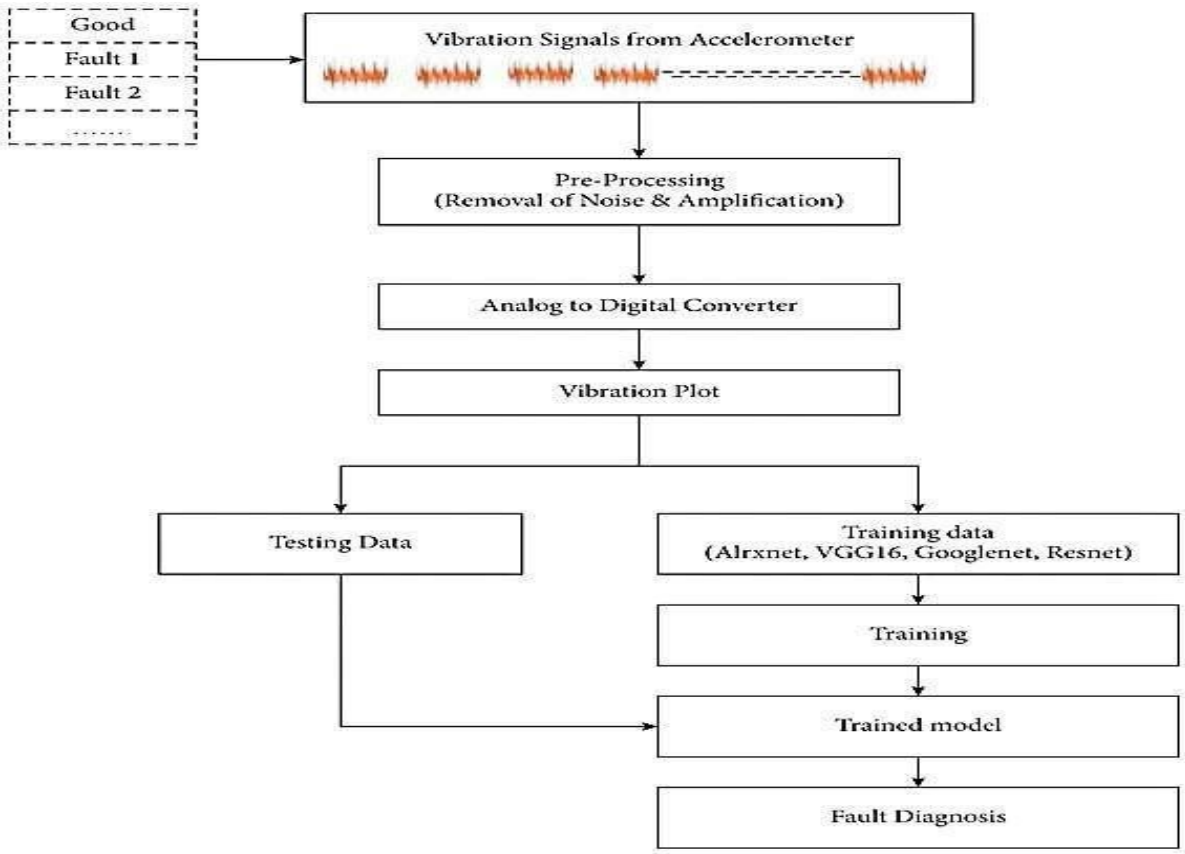
DECISION TREE FOR PROBLEMS IN AIR COMPRESSOR (CASE STUDY)

The air compressor pneumatic system malfunctions and the operator fails to run the system. Now, instead ofhaphazardly trying to repair the equipment, let the maintenance person make a systematic search for locatingthe faults. At the beginning let him check the pressure. If pressure is present, the disturbed direction of the driving member can be checked to see if air comes there or not. If not, the element can be checked in a methodical manner as shown in the tree branching chart.



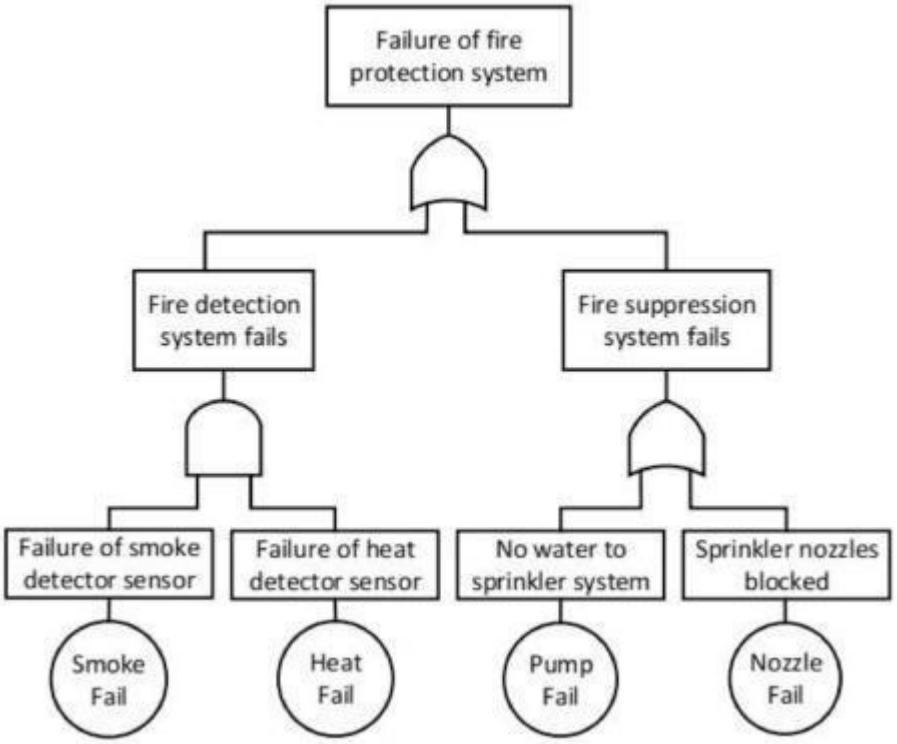
DECISION TREE FOR PROBLEMS IN INTERNAL COMBUSTION ENGINE

The experimental setup comprises of a spark-assisted gasoline-powered IC engine. Initially, the accelerometer was placed (using adhesive technique) on the engine to acquire the vibration signals for goodcondition. The same procedure is repeated further to acquire the vibration signals of misfire in the IC engine by cutting off the spark in the cylinder one by one. The complete methodology involved in the process of misfire detection in IC Engine is depicted in Figure



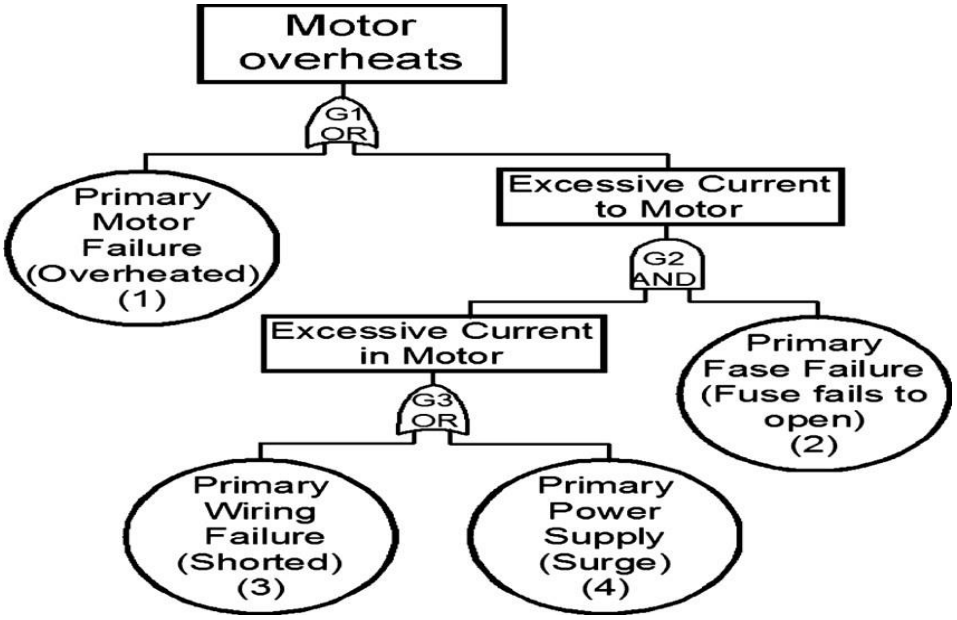
DECISION TREE FOR PROBLEMS IN BOILER

The function of a super-heater is to increase the temperature of the steam above its saturation point. The super-heater is very important accessory of a boiler and can be used in both fire tube and water-tube boilers.Catching of fire and occurring accidents often in boiler is common and to prevent this safety equipment andprotective alarm is provided. Any failure the system can be found through analyzing and deduction of failurecan obtain by Fault Finding Analyzing decision tree. An example is given below as a reference.



DECISION TREE FOR PROBLEMS IN ELECTRICAL MOTOR

Fault finding and decision making through the fault analysis chart is a major and foremost concept in any well-established firm to reduce time, labour and cost to attain the problem solving. Electrical motor whichconsumes more power and also rising temperature which lead to failure is taken as an example to draw a fault finding tree. It concludes with decision and remedial measures to solve the problem.



TYPES OF FAULTS IN MACHINE TOOLS AND THEIR GENERAL CAUSES.

Apparent Problems	Probable Causes
(a) Speed box heating up too much	(i) Lubrication and cooling not adequate. (ii) Bearings failure. (iii) Brake band rubbing on drum even when brake is not applied.
(b) Excessive noise in the gear box	(i) Gears damaged due to shifting while running. (ii) Bearing failure on any of the shafts.
(c) Main motor noisy	(i) Fan of motor may be loose. (ii) Motor bearing failure.
(d) Main motor does not start	(i) Electrical troubles (ii) Bearings or gears damaged.
(e) Speed changing lever not engaging properly	(i) Gears not sliding due to damaged shafts (ii) Universal joint failure. (iii) Taper pin in connecting shaft fallen out.
(f) Oil leakage from speed box	(i) Failure of oil seal of either input shaft or output shaft.