1. INTRODUCTION

The importance of drilling in the field of modern metal cutting is based on the fact that drilling is the most common of machining operations performed. The most popular tool is the twist drill, which was invented by Steven A. Morse in 1863 , who patented a new drill design, with two spiral flutes and a pointed cutting part, which exceptionally improved the cutting action and chip disposal. The modern twist drill geometry, though similar in the general appearance to the Morse drill, has been the subject of numerous improvements. Usually, a twist drill consists of two main cutting edges; the chisel edge and the cutting lips, as can be seen on Figure. Some drills have a secondary cutting edge, which significantly reduces the thrust forces and produces a cutting edge with a positive rake and a chip breaking point. The chisel edge protrudes into the workpiece material and contributes mostly to the thrust force. The cutting lips cut out the material and provide the majority of the drilling torque and thrust. During the drilling process, the chips are formed on the cutting edge and moved up along the drill helix angle

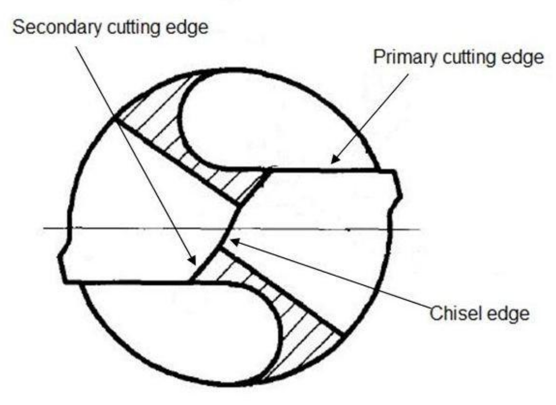


Fig. 1 The cutting edges of a standard twist drill

The growing demand for higher productivity, product quality and overall economy in manufacturing by machining, grinding and drilling, particularly to meet the challenges thrown by liberalization and global cost competitiveness, insists high material removal rate and high stability and long life of the cutting tools.

1.1 Nomenclature of Twist Drill

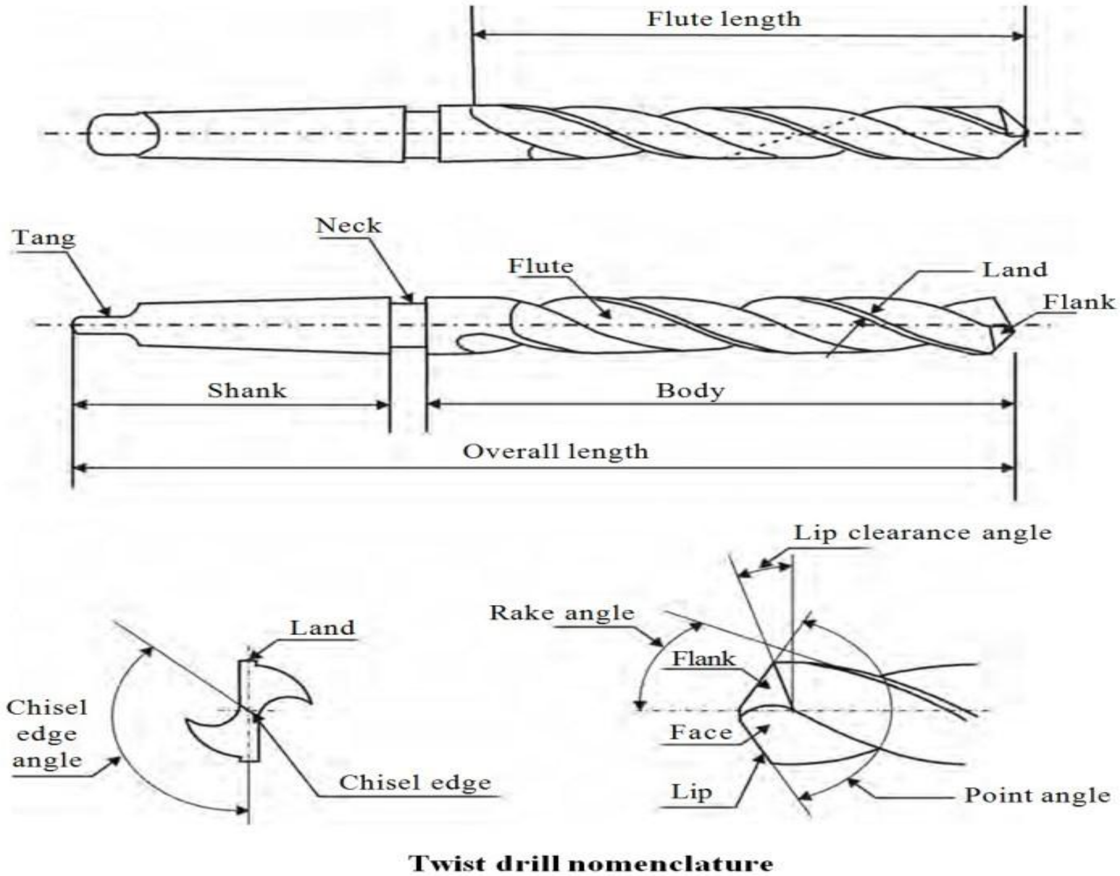


Fig.2 Nomenclature of twist drill

A drill or twist drill is a grooved end-cutting tool used for manufacturing holes in firm material. It basically consists of following parts

Body-The body of the twist drill spiral grooves cut on it. These grooves serve to offer clearance to the chips formed at the cutting edge. They also permit the cutting fluid to spread to the cutting edges.

Shank-It is a part that gets fitted into the drill chuck or sleeve. It might be parallel shank or taper shank. Smaller diameter drills have straight shank. This fits into a slot in the machine spindle, sleeve or socket and gives a positive grip.

Neck-It is the undercut portion between the body and the shank. Usually, size and other details are marked at the neck.

Point-It is the cone fashioned end of the drill. The point is shaped to produce lip, face, and flank and chisel edge or dead center.

Land or Margin-It is a narrow strip. It ranges back on the edge of the drill flutes. The size of drill is measured across the lands at the point end. Land retains the drill aligned.

Web-It is the central portion of drill located between the roots of the grooves and lengthening from the point towards the shank.

Chisel edge-The intersection of flank forms the chisel edge. This acts as a flat drill. It cuts a small hole in the work piece at the beginning. Therefore cutting edges removes further materials to complete the hole.

Cutting edge -The cutting edges of a drill are known as lips. Both lips should have equal length, same angle of inclination and correct clearance.

Flank-The surface behind the lip to the following flute is called flank.

Face-This is the portion of the flute surface adjacent to the lip. The chip impinges on it.

Heel-The edge which is formed by the intersection of the flute surface and the body clearance is known as heel.

Angles

Point angle-It is the angle between the cutting edges. It is generally 118 degree. Its value depends upon the hardness of the work piece to be drilled. For harder material, larger angles are used.

Helix angle-It is the angle between the leading edge of the land and the axis of the drill. It is also called as spiral angle.

Lip clearance angle-It is the angle formed by the portion of the flank adjacent to the land and a plane at right angles to the drill axis measured at the periphery of the drill.

Chisel edge angle-It is the obtuse angle between the chisel edge and the lip. Generally, this angle is 120 and 135 degree.

1.2 Material Used For Manufacturing Twist Drill

1.Carbon Steels-Low and high carbon steels are both used for drill bits, but for different purposes. Soft low carbon steel cannot cut hard metals due to their poor tempers, but they can cut wood. They require sharpening to extend their lifespan. The primary bonus of low carbon steel is its relative inexpensiveness, especially when compared to some more exotic drill bit materials.

High carbon steels have better tempers than low carbon steels, so they require less maintenance, such as sharpening, and hold their form and effectiveness longer. They can cut both woods and metals, and if available, are preferred to low carbon steels when cutting extremely hard woods.

2.High Speed Steel-High Speed Steel (HSS) is a special type of carbon steel that is prized for the way it can withstand high temperatures while maintaining structural integrity, specifically its hardness. Friction created by high speed turning can raise temperatures dramatically, but HSS can undergo these types of drillings. HSS can function at normal temperatures, as well, but only at a level equal to standard carbon steel. HSS can also take coatings, such as titanium nitrade, which give the drill bit better lubricity, decreasing friction and helping to extend the bit's life.

1.3 Designation And Standard Specification For High Speed Steel

High speed steels are alloys that gain their properties from either tungsten or molybdenum, often with a combination of the two. They belong to the Fe–C–X multi-component alloy system where X represents chromium, tungsten, molybdenum, vanadium, or cobalt. Generally, the X component is present in excess of 7%, along with more than 0.60% carbon. The alloying element percentages do not alone bestow the hardness-retaining properties; they also require appropriate high-temperature heat treatment to become true HSS.

1. Material in accordance with this specification is classified by chemical composition. Types correspond to respective

AISI designations.

a) Types T1, T2, T4, T5, T6, T8, and T15 are characterized by a controlled high tungsten content along with other alloying elements.

b) Types M1, M2, M3, M4, M6, M7, M10, M30, M33, M34, M36, M41, M42, M43, M44, M46, M47, M48, and M62 are characterized by a controlled high molybdenum content along with other alloying elements.

c) Types M2, M3, and M10 are further classified according to carbon range. Type M3 is further classified according to vanadium range.

d)Types M50 and M52 are considered intermediate high speed steels in view of their lower total alloy content than the standard types. These leaner alloy grades normally are limited to less severe service conditions.

Chemical Composition of some grades of High Speed Steels normally used is given below

Table no. 1 Chemical composition of HSS

HSS GRADES	**Chemical Composition**					
	Carbon	**Chromium**	**Molybdenum**	**Tungsten**	**Vanadium**	**Cobalt**
M2	0.86/0.96	3.8/4.5	4.9/5.5	6.0/6.75	1.7/2.2	Nil
M35	0.88/0.96	3.8/4.5	4.9/5.5	6.0/6.75	1.7/2.2	4.5/5.2
M42	1.05/1.5	3.5/4.5	9.0/10.0	1.3/2.0	1.0/1.3	7.75/8.2
T42	1.25/1.35	3.5/4.5	3.2.4.0	9.5/10.7	2.8/3.5	9.7/10.2

Influence of alloying elements on the steel properties:

Carbon: Forms carbides, increases wear resistance, is responsible for the basic matrix hardness.

Tungsten and Molybdenum: Improves red hardness, retention of hardness and high temperature strength of the matrix, form special carbides of great hardness.

Vanadium: Forms special carbides of supreme hardness, increase high temperature wear resistance, retention of hardness and high temperature strength of the matrix.

Chromium: Promotes deep hardening, produces readily soluble carbides.

Cobalt: Improves red hardness and retention of hardness of the matrix.

Molybdenum High Speed Steels (HSS)

Adding molybdenum, tungsten and chromium steel creates several alloys commonly called "HSS", measuring 63-65 Rockwell hardness.

M2:M2 is the "standard" and most widely used industrial HSS. It has small and evenly distributed carbides giving high wear resistance, though its decarburization sensitivity is a little bit high. After heat treatment, its hardness is the same as T1, but its bending strength can reach 4700 MPa, and its toughness and thermo-plasticity are higher than T1 by 50%. It is usually used to manufacture a variety of tools, such as drill bits, taps and reamers.

Cobalt High Speed Steels (HSS)

The addition of cobalt increases heat resistance, and can give a Rockwell hardness up to 67.

M35:M35 is similar to M2, but with 5% cobalt added. M35 is also known as Cobalt Steel, HSSE or HSS-E. It will cut faster and last longer than M2.

M42: M42 is a molybdenum-series high-speed steel alloy with an additional 8% or 10% cobalt. It is widely used in metal manufacturing industries because of its superior red-hardness as compared to more conventional high-speed steels, allowing for shorter cycle times in production environments due to higher cutting speeds or from the increase in time between tool changes. M42 is also less prone to chipping when used for interrupted cuts and costs less when compared to the same tool made of carbide. Tools made from cobalt-bearing high speed steels can often be identified by the letters HSS-Co.

2. PROJECT BACKGROUND

Indian Tool Manufacturers (ITM) - A Division of Birla Precision Technologies Ltd Aurangabad last year total drills produced value was 3526 lakhs In that (Bad flute and damage) defect rejection value is 15.58 lakhs which is contributed 0.44 %. This is one of the top defect in drills.

Problem Statement

After analysis of final inspection report data rejection due to bad flute & damage comes out one of the major defect. It is 0.44% of packing value. Due to this throughput Jobber production is affected.

Project Objectives

1. Inspection of problem related to bad flute and damage rejection of drills and study of causes related to them.

2. Implementation of countermeasure plans on priority causes.

3. Reducing bad flute and damage rejection value in drills.

3. TWIST DRILL BIT MANUFACTURING PROCESS

1. Blank Cutting: The high speed steel rods from storage section are send to blank cutting section where on blank cutting machine required size of blanks are cut from rod.

Fig.3 Blank cutting

2. Heat Treatment: Cutted blanks from blank cutting section then forwarded to heat treatment section. Following heat treatment are carried on HSS Grade steel

1. Preheating
2. High heating
3. Quenching
4. Tempering a) 1st Tempering b) 2nd Tempering c) Steam Tempering

Fig.4 Heat Treatment

Salt used for furnace and quenching

1. Preheat salt 660

2. High heat salt 970

3. Quenching salt 495

After the heat treatment samples are taken off for testing in metallurgy lab

3. Blank Grinding: Blank received from the H.T. section are then grind on surface grinding machine. Due to the surface grinding all the dirt is removed and blank attend their final diameter for further processes

Fig.5 Blank Grinding

4. Flute Grinding: Up next blank are send for the flute grinding on respected machine. Gefra series of machines are used for flute grinding.

Fig.6 Flute Grinding

5. Finish Grinding: After flute grinding any extra edges produce from the flute grinding are cut in finish grinding

Fig.7 Finish Grinding

6. Clearance Grinding: In Clearance grinding margin is cut on the drill blank. It is also known as land, It ranges back on the edge of the drill flutes.

Fig.8 Clearance Grinding

7. Point Grinding: In point grinding chisel edge, point angle, face and lip of the drill is form.

Fig.9 Point Grinding

8. Cleaning: After the point grinding jobs are washed and clean and send for final inspection.

Fig.10 Cleaning

9. Final Inspection: Drills are check in the Inspection department for any errors. If any error is found then it is rejected.

Fig.11 Final Inspection

10. Marking: Here Company symbol and name is mark on the drills.

Fig.12 Marking

11. Packing: After the marking drills are packed in box and stored

Fig.13 Packing

4. PARETO ANALYSIS

4.1 What is a 'Pareto Analysis'

A technique used for decision making based on the Pareto Principle, known as the 80/20 rule. It is a decision-making technique that statistically separates a limited number of input factors as having the greatest impact on an outcome, either desirable or undesirable. Pareto analysis is based on the idea that 80% of a project's benefit can be achieved by doing 20% of the work or conversely 80% of problems are traced to 20% of the causes.

Taking inventory as an example, the first step in the analysis is to identify those criteria which make a significant level of control important for any item. Two possible factors are the usage rate for an item and its unit value. Close control is more important for fast moving items with a high unit value. Conversely, for slow moving, low unit value items the cost of the stock control system may exceed the benefits to be gained and simple methods of control should be substituted. These two factors can be multiplied to give the annual requirement value (ARV) - the total value of the annual usage.

If the stock items are then listed in descending order of ARV, the most important items will appear at the top of the list. If the cumulative ARV is then plotted against number of items then a graph known as a Pareto curve is obtained.

In its simplest terms, Pareto analysis will typically show that a disproportionate improvement can be achieved by ranking various causes of a problem and by concentrating on those solutions or items with the largest impact. The basic premise is that not all inputs have the same or even proportional impact on a given output. This type of decision-making can be used in many fields of endeavor, from government policy to individual business decisions.

4.2 Understanding And Using Pareto's 80-20 Rule

The Pareto 80/20 Rule is commonly used (and also ignored at considerable cost) in many aspects of organizational and business management.
It is helpful in specialised quality management such as six sigma, planning, decision-making, and general performance management.

Pareto theory is also an extremely helpful reference or 'check' in business/organizational planning and project management too.

Leadership is a lot easier and effective when Pareto principles are kept in mind, and this applies to every form of leadership theory and approach.

The Pareto principle is extremely helpful in bringing swift and easy clarity to complex situations and problems, especially when deciding where to focus effort and resources.

Pareto's Law is dramatically effective when applied to selling and marketing situations - because it encourages a focus of activity and energy that usually produces very fast and substantial improvements (for example when applied to target audiences, existing customers, product ranges, pricing, etc., and other major 'profit levers'). Really, it's impossible to overstate the effectiveness of the theory in these areas, despite which the use of Pareto theory in sales and marketing is commonly overlooked completely.

Pareto's 80-20 theory extends particularly to time management - in work, business, organizational management, and certainly personal time management outside of work too.

The Pareto Principle (at a simple level) suggests that where two related data sets or groups exist (typically cause and effect, or input and output), for example:

- "80 percent of output is produced by 20 percent of input"
- "80 percent of outcomes are from 20 percent of causes"
- "80 percent of contribution comes from 20 percent of the potential contribution available"

There is no single definitive Pareto 'quote' or definition - the above are examples of simple interpretations of Pareto's 80-20 Rule, for which a very wide range of similar alternatives could be used instead, depending on the situation, including inversions, for example:

- "20 percent of clothes in a wardrobe are worn 80 percent of the time"
- "20 percent of the tools in a toolbox are used in 80 percent of tasks"
- "20 percent of the energy use in a household will offer 80% of the potential energy savings"

The Pareto Principle is an extremely useful model or theory with endless applications - in management, social study and demographics, all types of distribution analysis, business and financial planning and evaluation, and also for organizing your work and life.

For example, household energy savings can be dramatic and easy if you identify the 20% of energy use which offers 80% of the potential savings available. Just as DIY can be made more efficient if the 20% of tools that are used for 80% of tasks are organized to be the most accessible in the toolbox, or the 20% of clothes worn 80% of the time are are organized to be most accessible in the wardrobe...

In fact the Pareto Principle does not demand that the 80:20 ratio applies to every situation, and neither is the model based on a ratio in which the two figures must add up to 100**.**

So the examples used here are not statistical facts; the 80-20 ratio is used to show that the Pareto distribution principle can be applied to many different situations.

Often the optimal ratio (in terms of identifying the smallest proportion that will produce the greatest improvement) is closer to 90:10, or even 99:1.

Also, the numbers in the ration do not have to add up to 100. The two numbers in an optimal ratio may total more than 100 or less than 100.

For example a situation can exist where 99% of the result is produced by 15% of the factors, or where 75% of the results derive from 5% of the factors.

So even where a situation does contain a 80:20 correlation, other ratios might be more significant, for example:

- 99:22 (illustrating that even greater concentration than 80:20 and therefore significance at the 'top-end') or
- 5:50 (i.e., just 5% results or benefit coming from 50% of the input or causes or contributors, obviously indicating an enormous amount of ineffectual activity or content).

The reasons that 80:20 has become the 'standard' ratio associated with the effect are:

- the 80-20 correlation was the first to be discovered and published
- 80-20 remains the most striking and commonly occurring ratio
- and since its discovery, the 80:20 ratio has always been used as the name and basic illustration of the Pareto theory.

Here are some examples of Pareto's Law as it applies to various situations. According to the Pareto Principle, it will generally the case (broadly - remember it's a guide not a scientific certainty), that within any given scenario or system or organisation:

- 80 percent of results come from 20 percent of efforts

- 80 percent of activity will require 20 percent of resources
- 80 percent of usage is by 20 percent of users
- 80 percent of the difficulty in achieving something lies in 20 percent of the challenge
- 80 percent of revenue comes from 20 percent of customers
- 80 percent of problems come from 20 percent of causes
- 80 percent of profit comes from 20 percent of the product range
- 80 percent of complaints come from 20 percent of customers
- 80 percent of sales will come from 20 percent of sales people
- 80 percent of corporate pollution comes from 20 percent of corporations
- 80 percent of work absence is due to 20 percent of staff
- 80 percent of road traffic accidents are cause by 20 percent of drivers
- 80 percent of a restaurant's turnover comes from 20 percent of its menu
- 80 percent of your time spent on this website will be spent on 20 percent of this website
- and so on..

Remember for any particular situation the precise ratio can and probably will be different to 80:20, but the principle will apply nevertheless, and in many cases the actual ratio will not be far away from the 80:20 general rule.

Such a principle is extremely useful in planning, analysis, trouble-shooting, problem-solving and decision-making, and change management, especially when broad initial judgments have to be made, and especially when propositions need checking. Many complex business disasters could easily have been averted if the instigators had thought to refer to the Pareto Principle as a 'sanity check' early on. Pareto's Law is a tremendously powerful model, all the more effective because it's so simple and easy.

For example, consider an organisation which persists in directing its activities equally across its entire product range when perhaps 95% of its profits derive from just 10% of the products, and/or perhaps a mere 2% of its profits come from 60% of its product range. Imagine the wasted effort... Instead, by carrying out a quick simple 'Pareto analysis' and discovering these statistics, the decision-makers could see at a glance clearly where to direct their efforts, and probably too could see a whole lot of products that could be discontinued. The same effect can be seen in markets, services, product content, resources, etc; indeed any situation where an 'output:input' or 'effect:cause' relationship exists.

Discovery and history of pareto's principle

Pareto's Principle is named after the man who first discovered and described the '80:20' phenomenon, Vilfredo Pareto (1848-1923), an Italian economist and sociologist. Pareto was born in Paris, and became Professor of Political Economy at Lausanne, Switzerland in 1893.

An academic, Pareto was fascinated by social and political statistics and trends, and the mathematical interpretation of socio-economic systems.

Vilfredo Pareto first observed the '80/20' principle when researching and analysing wealth and income distribution trends in nineteenth-century England (although some people suggest it was Italy - see the note below about England or Italy).

This discovery, its implications, and his wider findings appeared in the book: Cours d'Économie Politique (1896/97).

Pareto noted that broadly 20 percent of the people owned 80 percent of the wealth.

Beyond this Pareto also realised that this 'predictable imbalance' could be extrapolated (extended) to illustrate that, for example, 10 per cent would have 65 percent of the wealth, and 5 percent of people would own 50 percent of the wealth.

Be aware that these other stated ratios are what Pareto found in his particular study - they are not scientific absolutes that can be transferred reliably to other situations, although the principle of 'varying ratios of disproportionate distribution' definitely can be found/applied in other situations.

Pareto then tested his 80-20 principle (including related numerical correlations) on other countries, and all sorts of other distribution scenarios, by which he was able to confirm that the 80:20 Principle, and similarly imbalanced numerical correlations, could be used reliably as a model to predict and measure and manage all kinds of effects and situations.

Thus while the very first application of the Pareto Principle, or 80-20 Rule, was originally in Pareto's suggestion that "Eighty percent of the wealth is held by twenty percent of the people," the principle was and can be extended to apply to almost all other distribution scenarios as well.

As a mathematical political and sociological innovator, Pareto developed other theories, for instance his 1916 book The Mind and Society predicted the growth of Fascism in Europe.

His most famous discovery was however the '80/20' statistical rule that bears his name.

Sadly Pareto didn't live to see the general appreciation and wide adoption of his principle; he seems to not have been particularly effective at explaining and promoting the theory beyond academic circles, and it was left to other experts such as George Zipf and Joseph Juran to develop and refine Pareto's theories to make them usable and popular in business and management later towards the middle of the 20th century.

Pareto Chart Procedure

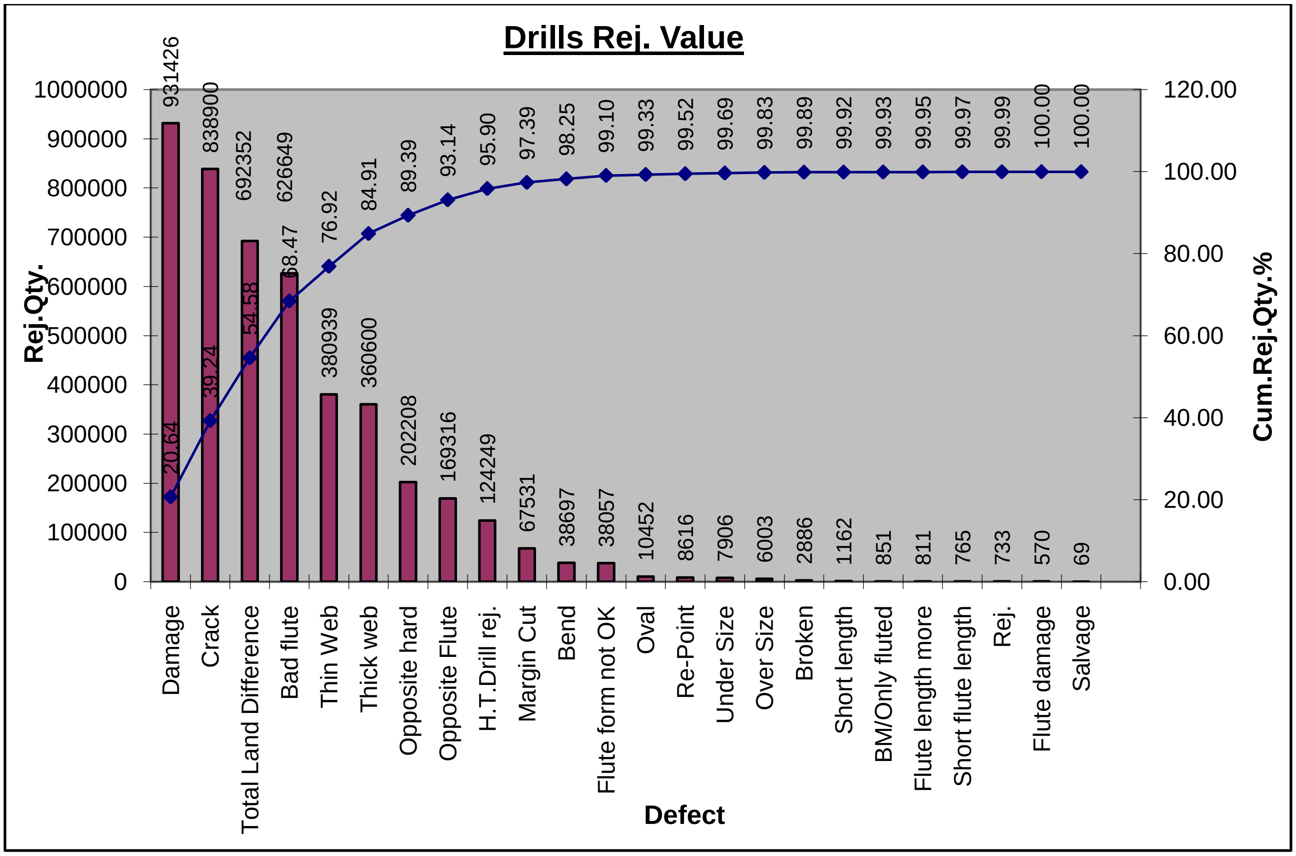
Here are eight steps to identifying the principal causes you should focus on, using Pareto Analysis:

1. Create a vertical bar chart with causes on the x-axis and count (number of occurrences) on the y-axis.
2. Arrange the bar chart in descending order of cause importance that is, the cause with the highest count first.
3. Calculate the cumulative count for each cause in descending order.
4. Calculate the cumulative count percentage for each cause in descending order. Percentage calculation: {Individual Cause Count} / {Total Causes Count}*100
5. Create a second y-axis with percentages descending in increments of 10 from 100% to 0%.
6. Plot the cumulative count percentage of each cause on the x-axis.
7. Join the points to form a curve.
8. Draw a line at 80% on the y-axis running parallel to the x-axis. Then drop the line at the point of intersection with the curve on the x-axis. This point on the x-axis separates the important causes on the left from the less important causes on the right.

4.3 Pareto Chart For Defects In Drill:

Following chart shows the pareto chart for drill defect causes.

Chart 1: Pareto chart for defects in drill



Here using sample data showing the relative frequency of causes for defects on drills. It enables to see what 20% of cases are causing 80% of the problems and where efforts should be focussed to achieve the greatest improvement.

In this case, we can see that Damage due to errors, Cracks in drills, Total land difference and bad flute tags should be the focus.

5. CAUSE AND EFFECT ANALYSIS

When utilizing a team approach to problem solving, there are often many opinions as to the problem's root cause. One way to capture these different ideas and stimulate the team's brainstorming on root causes is the cause and effect diagram, commonly called a fishbone. The fishbone will help to visually display the many potential causes for a specific problem or effect. It is particularly useful in a group setting and for situations in which little quantitative data is available for analysis. Cause and Effect Analysis was devised by professor Kaoru Ishikawa, a pioneer of quality management, in the 1960s.

The fishbone then consists of one line drawn across the page, attached to the problem statement, and several lines, or "bones," coming out vertically from the main line. These branches are labeled with different categories.

Cause and Effect: Looking Back

Cause and Effect analysis is typically used to figure out why something went wrong. Your product is failing, your clients are frustrated, and you're losing money. But why? After all, everything was fine up until three months ago. By analyzing the production process, you may be able to pinpoint the issues that are to blame. Once you've determined where the issues lie, you can address them—and institute policies to ensure that those same issues don't arise again.

Cause and Effect analysis can also help you to replicate a positive outcome. For example, this month—for the first time ever—your team exceeded its sales goals. What went right? It's easy to say "we got lucky," but most of the time we make or at least encourage our own luck. So what were the elements that went into making this month's sales calls so much more effective than before?

Cause and Effect: Planning for the Future

While Cause and Effect Analysis is typically used to understand what has happened (usually in order to avoid having it happen again), it can also be used to help plan for the future. How? Rather than attempting to explain an existing outcome, it is possible to set up a hoped-for outcome, and then analyze the elements required to bring the outcome about. Once you have a clear idea of what's needed, it's much easier to create a plan of action that is likely to succeed.

Because the process of analysis involves breaking down the whole into a set of individual parts, you can also use the chart created through Cause and Effect Analysis to determine who should take responsibility for which aspects of the project. If you spent a good deal of time on the process, you may even have the start of a to-do list for various members of the project team.

5.1 How to Conduct Cause and Effect Analysis

Cause and Effect Analysis, as it's conducted in business today, is one of several Japanese innovations intended to improve quality and quality control. The process is conducted using a fishbone chart (so named because it looks like a fish skeleton)—otherwise known as an Ishikawa diagram. Ishikawa diagrams were designed during the 1960's by Kaoru Ishikawa, who managed quality control of processes in the Kawasaki Shipyard.

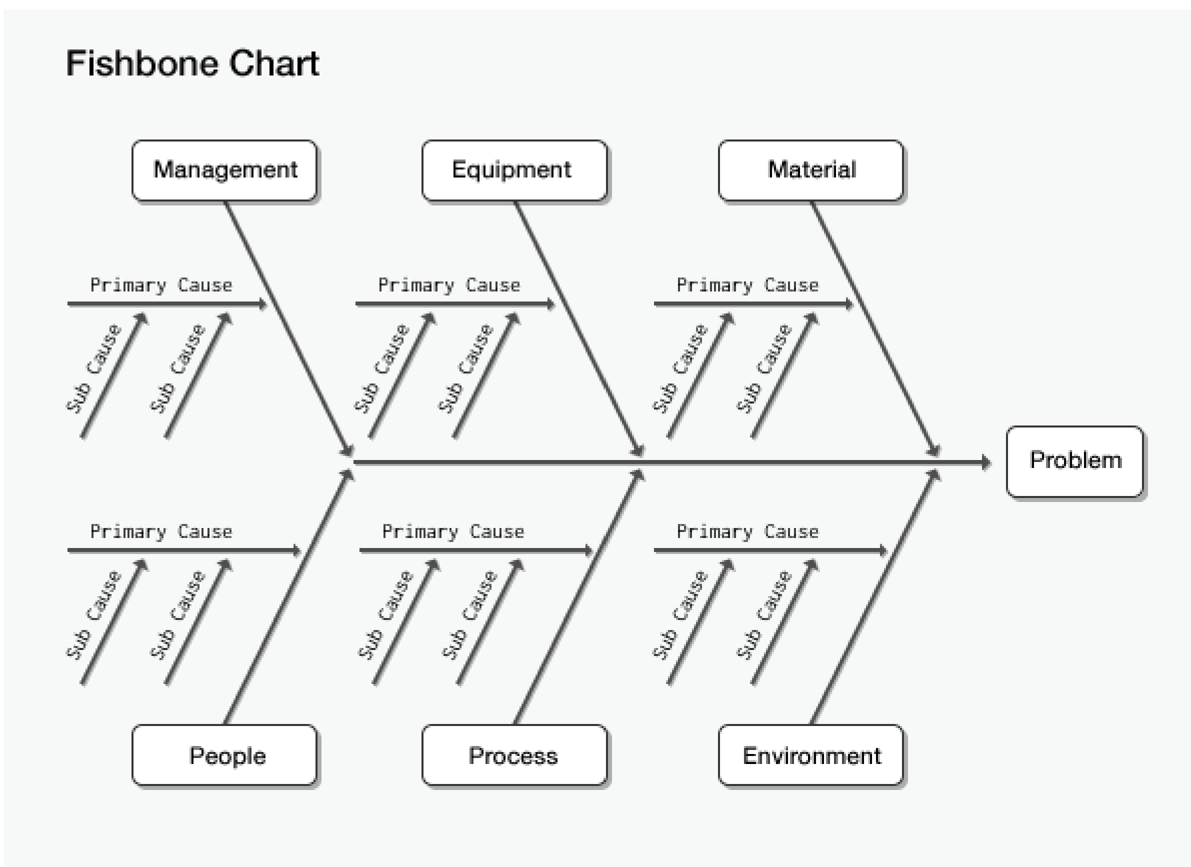


Fig.14 Fishbone Chart Template

The fishbone chart approach to cause and effect analysis uses a standard chart to encourage brainstorming and to visually present findings. When the chart is complete, it is possible to analyze findings together, and to determine the most important factors involved in either solving a problem or achieving success. There are four steps involved with cause and effect analysis. They include identification of the problem or goal, brainstorming, analysis, and development of an action plan.

Step 1: Identify the Problem or Goal

The entire team must agree in order for the process to be successful. The goal or problem is then written on the "head" of the fish. Let's say that the team's goal is to ensure that sales reports are completed in a timely manner at the end of each month. Once the team agrees to this, the facilitator draws a line with a box or "fish head" at the end. The goal is written in the box.

Step 2: Brainstorm

What will it take to get your sales team, your managers, and your report writer to work together and produce the needed reports in a timely manner? Often, it's helpful to start with the six general areas that are most likely to impact almost any business project; these become the primary bones of the fish.

- Management
- Equipment
- Material
- People
- Process
- Environment

Those six areas, however, are not mandatory; the State of North Carolina's website lists other options as follows:

- The 4 M's: Methods, Machines, Materials, Manpower.
- The 4 P's: Place, Procedure, People, Policies.
- The 4 S's: Surroundings, Suppliers, Systems, Skills.

Even these, however, are just suggestions. Many organizations come up with their own categories, selected to reflect their real-world situation.

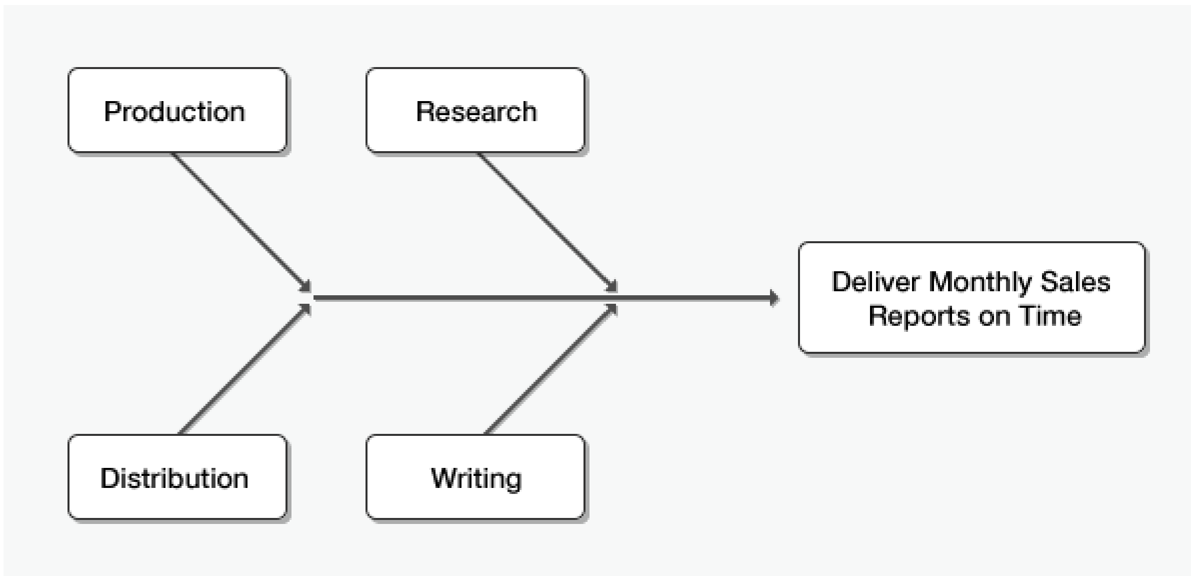


Fig.15 Cause and effect model

Step two continues with additional brainstorming details based on general categories. Which people are needed to meet the goal? Each new detail is indicated by a new line drawn perpendicular to the bone before it. As details are added through the brainstorming process, more "bones" are added to the chart; in some cases the chart can wind up looking very complex, because there are so many levels of detail to be considered.

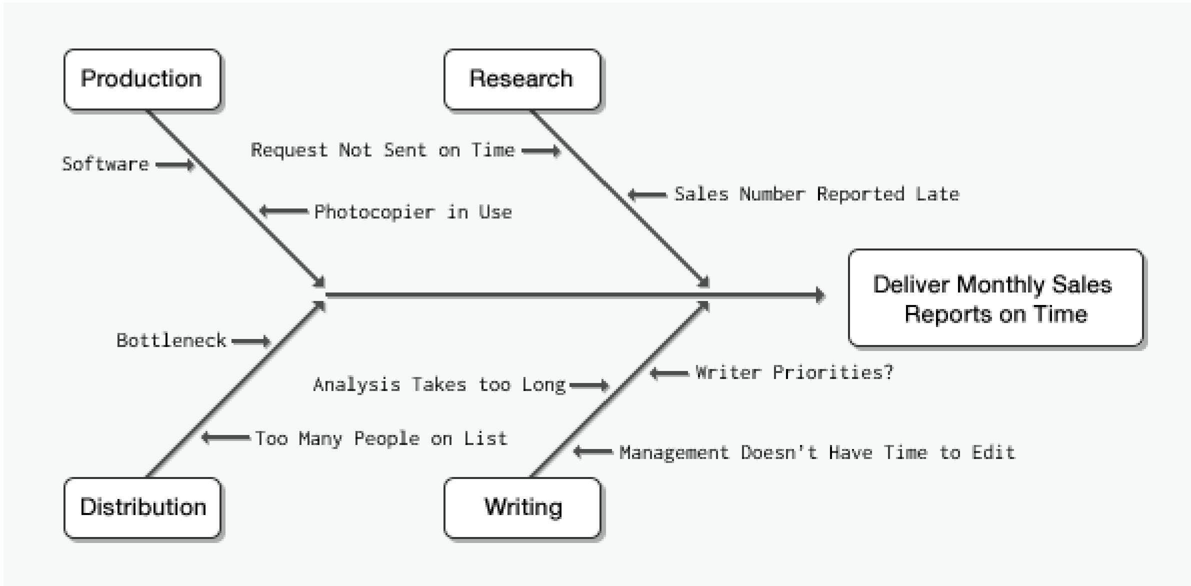


Fig.16 Cause and effect diagram example

Step 3: Chart Analysis

Spend some time reviewing the chart. Do you see the same needs or concerns popping up in different places? What are the most critical items, without which you are certain to fail?

As you and your team look at the chart, it is very likely that major themes will begin to emerge. You'll circle those themes on the fishbone chart, and then organize them on a separate page. You might want to organize major themes by their importance, or in chronological order.

Step 4: Develop an Action Plan

Based on your fish bone chart and your analysis, a clear set of priorities should emerge. These priorities will help you to put together a plan that can be implemented immediately.

Fishbone Diagram Procedure: Agree on a problem statement (effect). Write it at the center right of the flipchart or whiteboard. Draw a box around it and draw a horizontal arrow running to it.

1. Brainstorm the major categories of causes of the problem. If this is difficult use generic headings:

- Methods
- Machines (equipment)
- People (manpower)
- Materials
- Measurement
- Environment

2. Write the categories of causes as branches from the main arrow.
3. Brainstorm all the possible causes of the problem. Ask: "Why does this happen?" As each idea is given, the facilitator writes it as a branch from the appropriate category. Causes can be written in several places if they relate to several categories.
4. Again ask "why does this happen?" about each cause. Write sub–causes branching off the causes. Continue to ask "Why?" and generate deeper levels of causes. Layers of branches indicate causal relationships.
5. When the group runs out of ideas, focus attention to places on the chart where ideas are few.

Structure of cause and effect diagram:

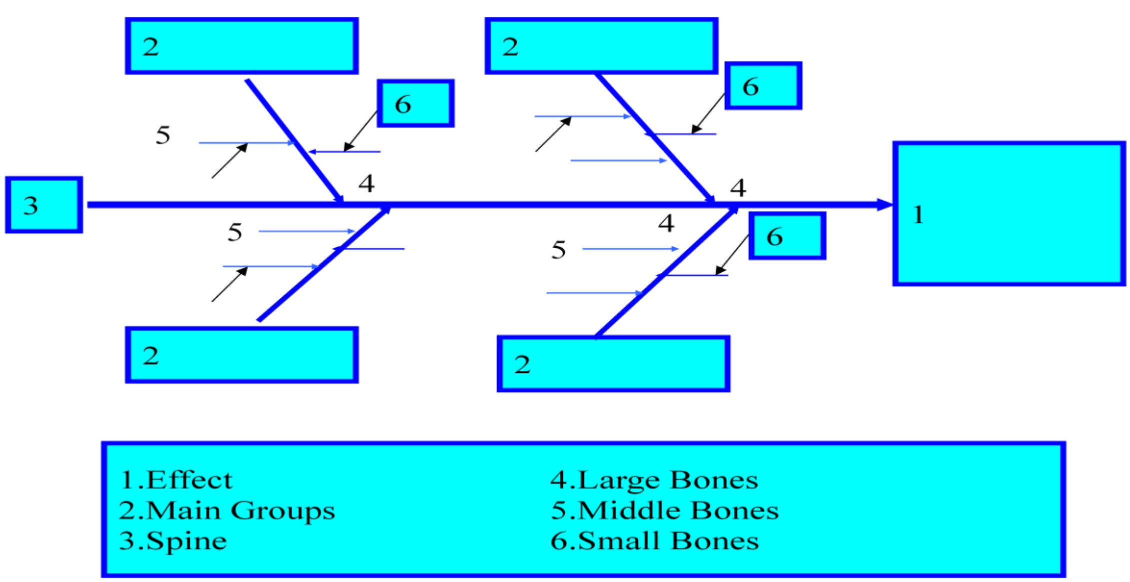


Fig.17 Structure of cause and effect diagram

5.2 Causes for Bad flute and Damage:

a) For Bad Flute:

1. MAN

A. Unskilled Operator

B. Negligence by Operator

C. Lack of Knowledge

D. Setting is not proper

2. MACHINE

A. Collet got loose in running

B. Indexing problem

C. Gear train slipped

D. Loading is not proper.

E. Diamond dressing is worn out

F. Cycle problem

G. Coolant problem

H. Lifting problem. Hydraulic pressure is not proper.

3. MATERIAL

A. Blank oversize

B. Blank undersize

C. Ovality blank

D. Taper blank

4. METHOD

A. Patrol inspections not followed properly

B. First piece inspection not followed properly

C. Flute dressing is not proper

D. Center less grinding operation is not proper

E. M/c run idle due to hopper problem

F. Lead pin coming out in running

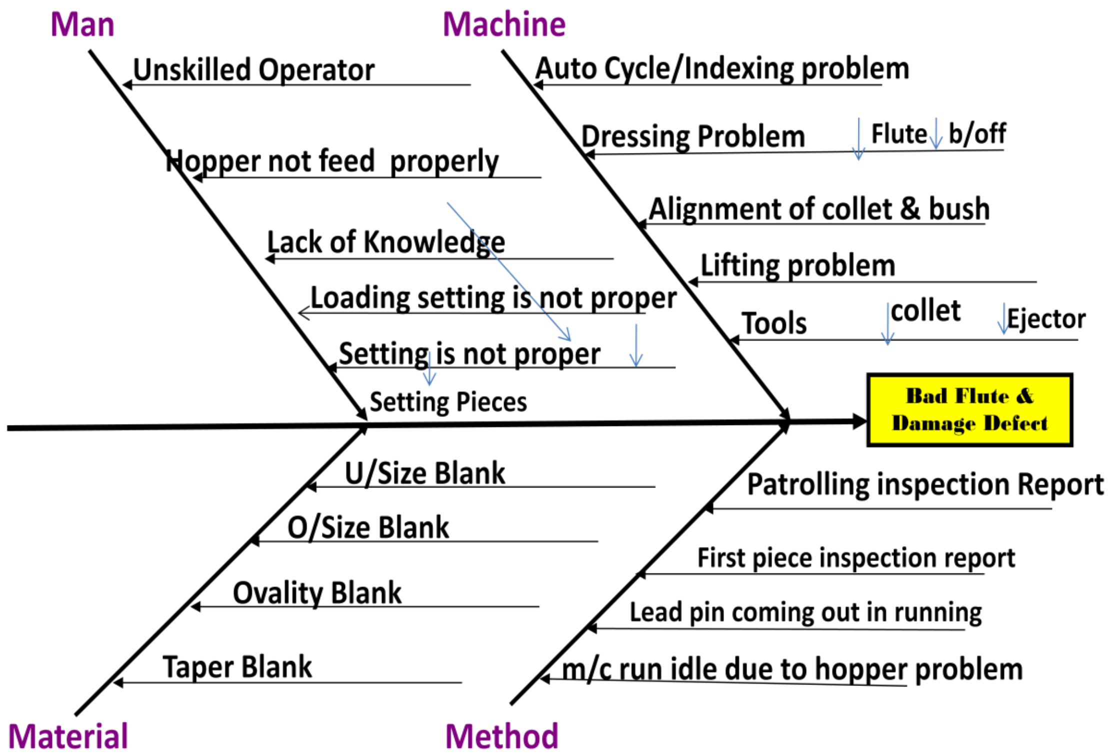


Fig.18 CAUSE & EFFECT DIAGRAM for (Bad flute)

b) For Damage

1. MAN

A. Unskilled Operator

B. Negligence by Operator

C. Lack of Knowledge

D. Setting is not proper

2. MACHINE

A. Auto cycle problem

B. Turret movement problem

C. Alignment of collet & Bush is not proper.

D. Tooling is not proper

E. Setting block play problem

3. MATERIAL

A. Wheel thickness is more.

B. U/size blank problem

4. METHOD

A. B/off Side dressing is not proper.

B. Setting is not proper

C. Cycle movement is not proper

D. Patrolling inspection is not followed properly

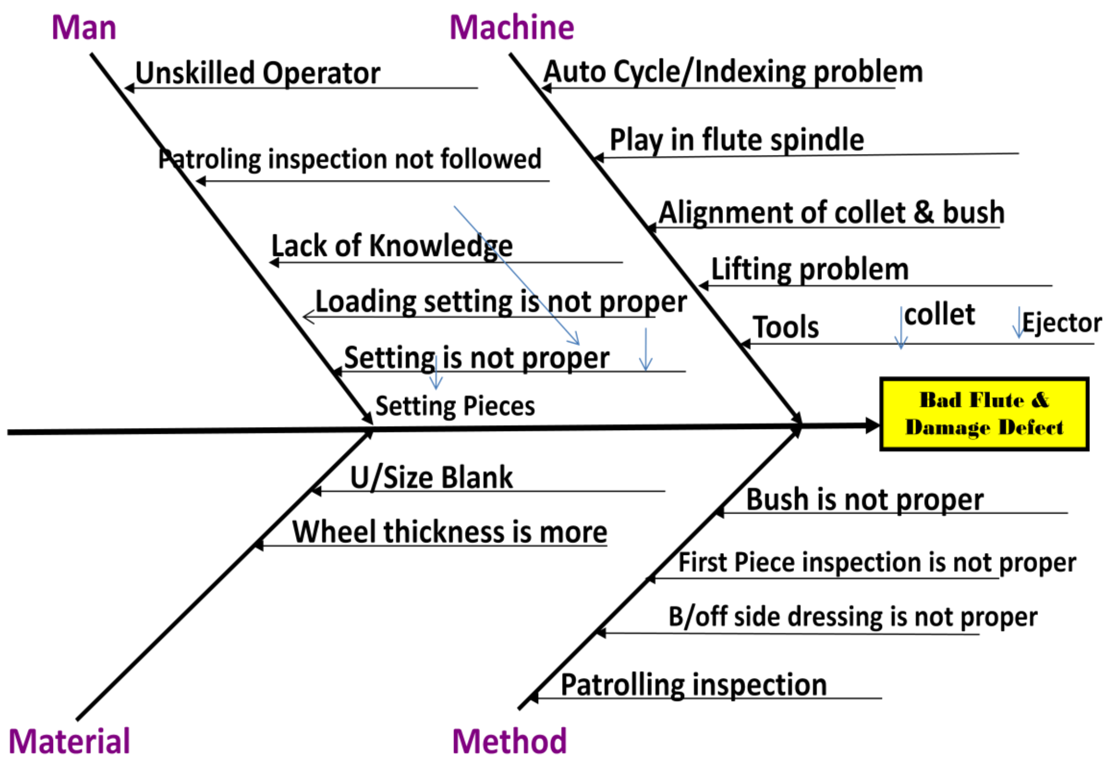


Fig.19 CAUSE & EFFECT DIAGRAM for (Damage)

6. CONTROL CHART

Control charts, also known as Shewhart charts (after Walter A. Shewhart) or process-behavior charts, are a statistical process control tool used to determine if a manufacturing or business process is in a state of control. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

When a process is stable and in control, it displays common cause variation, variation that is inherent to the process. A process is in control when based on past experience it can be predicted how the process will vary (within limits) in the future. If the process is unstable, the process displays special cause variation, non-random variation from external factors.

Control charts are simple, robust tools for understanding process variability.

When to Use a Control Chart

- When controlling ongoing processes by finding and correcting problems as they occur.
- When predicting the expected range of outcomes from a process.
- When determining whether a process is stable (in statistical control).
- When analyzing patterns of process variation from special causes (non-routine events) or common causes (built into the process).
- When determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process.

Control Chart Basic Procedure

1. Choose the appropriate control chart for your data.
2. Determine the appropriate time period for collecting and plotting data.
3. Collect data, construct your chart and analyze the data.
4. Look for "out-of-control signals" on the control chart. When one is identified, mark it on the chart and investigate the cause. Document how you investigated, what you learned, the cause and how it was corrected.

Out-of-control signals

- A single point outside the control limits. In Figure 1, point sixteen is above the UCL (upper control limit).
- Two out of three successive points are on the same side of the centerline and farther than 2 σ from it. In Figure 1, point 4 sends that signal.
- Four out of five successive points are on the same side of the centerline and farther than 1 σ from it. In Figure 1, point 11 sends that signal.
- A run of eight in a row are on the same side of the centerline. Or 10 out of 11, 12 out of 14 or 16 out of 20. In Figure 1, point 21 is eighth in a row above the centerline.
- Obvious consistent or persistent patterns that suggest something unusual about your data and your process.

5. Continue to plot data as they are generated. As each new data point is plotted, check for new out-of-control signals.

6. When you start a new control chart, the process may be out of control. If so, the control limits calculated from the first 20 points are conditional limits. When you have at least 20 sequential points from a period when the process is operating in control, recalculate control limits.

6.1 CONTROL CHARTS FOR ATTRIBUTES

Practical Limitations of the Control Chart for Variables

X and R charts are powerful devices for the diagnosis of quality and means for routine detection of sources of trouble. But their use is limited to only a small fraction of quality characteristics, specified for manufactured product. The limitations of X and R charts are as discussed below.

1. X and R charts can be used for quality characteristics that can be mess and expressed in numbers. However, many quality characteristics can be observed only as attributes, i.e., by classifying each item inspected into one of the two classes, either conforming or non-conforming to the specifications. For example, while' inspecting the castings in addition to conformity to dimensions, it may be necessary to inspect other quality characteristics such as blow holes, cracks, swells, undercuts finish, etc. each of which singly or in combination may make the casting defective' This type of data can be collected only on the basis of number of products that conforms to the specifications and the number of products failing to conform to the specifications.

2. Furthermore, X and R charts can be used only for one measurable characteristic at a time. For example, a firm may be producing a part or an assembly involving 50 different dimensions (or quality characteristics). For each dimension a separate X and R chart is necessary, however, it will be impracticable and uneconomical to have 50 such charts and hence the manufacturer may prefer to analyze the results in terms of defective or non-defective items.

3. For reason of economy even in some cases, where the direct measurement of variable quality characteristics is possible, it is common practice to classify them as good or bad on the basis of inspection by Go-No-Go gauges. In such cases X and R charts may be plotted for the most important and troublesome quality characteristic.

No dimension should be chosen for X and R chart unless there is an opportunity to save cost from reduction of spoilage, rework etc. The quality improvement resulted from the X and R chart together with the opportunity to save cost should compensate the cost of taking the measurement, keeping the charts and analyzing them. As an alternative to X and R charts, and as a substitute when characteristic is measured only by attribute a control chart based on fraction defective P is used. (P-chart)

Fraction defective, P' articles found in any inspection be defined as the ratio of the number of defective articles found in any inspection to the total number of articles actually inspected. Fraction defective is always expressed as a decimal fraction.

Selection of subgroups

In all control charts, subgroups be selected should be such that, the chances of variation within the subgroup should minimum. Similar to the X and R charts, in the control chart for fraction defection the most natural basis for selecting subgroup is the order in which production takes place.

Generally, subgroups selected should consist of items produced in a day or products produced in one production order. Sometime a control chart showing daily per cent defective may be supplemented by charts showing weekly and monthly figures. The daily chart may be used as a basis for current action on the manufacturing process by production supervisors, methods analyst, and operators : the weekly chart may be used by manufacturing executives such as departmental heads ; the monthly chart may be used in quality reports to top management. Where the subgroup consists of daily or weekly production, the subgroup size is almost certain to vary. In this case three possible solutions to the problem are :

1. Compute control limits for every subgroup and show these fluctuating limits on the p chart.

2. Estimate the average subgroup size, and compute one set of limits for this average and draw them on control chart. This method is approximate and is appropriate only when the subgroup sizes are not too variable. Points near the limits may have to be re-examined in accordance with (1).

3. Draw several sets of control limits on the chart corresponding to different subgroup sizes. This method is also approximate and is actually across between (1) and (2), again points falling near the limits should be re-examined in accordance with (1).

Choice between 'p' chart and 'np' chart

Whenever subgroup size is variable control chart for fraction defective (p chart) is used. However, if subgroup size is contain the chart for actual number of defectives, known as np chart is used. When subgroup size is constant, the np chart is preferred over p chart for the following reasons

1) np chart saves one calculations for each subgroup, the division of number of defectives by sub group size to get fraction defective

2) Some people may understand the np chart more readily.

Control Charts for Defects

Difference between a defect and defective.

An item is said to be defective if it fails to conform to the specifications in any of the characteristics. Each characteristics that does not meet the specification is a defect. For example, if a casting hard spots, blow holes etc., the casting is defective and the hard spots, blow holes etc. which makes the casting defective are the defects.

The np chart, applies to the number of defectives in subgroups of constant size. Whereas C chart applies to the number of defects in a subgroup of constant size. In most of the cases, each subgroup for C chart consists of a single article and the variable C consists of the number of defects observed in one an However, it is not necessary that the subgroup for the C chart be a single article, it is essential only that the subgroup size be constant in the sense that the different subgroups have substantially equal opportunity for the occurrence of defects.

6.2 ‘P’ Control Charts

A p control chart is used to look at variation in yes/no type attributes data. There are only two possible outcomes: either the item is defective or it is not defective. The p control chart is used to determine if the fraction of defective items in a group of items is consistent over time.

A product or service is defective if it fails to conform to specifications or a standard in some respect. For example, consider the case of a customer calling the company to place an order. The customer would probably not like to have the phone ring 10 to 15 times before it is answered. Suppose you have determined that the operational definition for answering the phone in a timely fashion is "to answer the phone on three or fewer rings." Using this definition, you could monitor the fraction of phone calls answered or not answered in a timely fashion. If a phone call is answered on or before the third ring, the item (answering the phone call) is not defective. If the phone call is not answered on or before the third ring, the item is defective.

You use a p control chart when you have yes/no type data. This type of chart involves counts. You are counting items. To use a p control chart, the counts must also satisfy the following two conditions:

1. You are counting n items. A count is the number of items in those n items that fail to conform to specification.
2. Suppose p is the probability that an item will fail to conform to the specification. The value of p must be the same for each of the n items in a single sample.

If these two conditions are met, the binomial distribution can be used to estimate the distribution of the counts and the p control chart can be used. Be careful here because condition 2 does not always hold. For example, some people use the p control chart to monitor on-time delivery on a monthly basis. This is not valid unless the probability of each shipment during the month being on time is the same for all the shipments. Big customers often get priority on their orders, so the probability of their orders being on time is different than that of other customers and you can't use the p control chart. The example below will take you through the steps to construct a p control chart.

6.3 'np' Control Charts

An np control chart is used to look at variation in yes/no type attributes data. There are only two possible outcomes: either the item is defective or it is not defective. The np control chart is used to determine if the number of defective items in a group of items is consistent over time. The subgroup size (the number of item in the group) must be the same for each sample.

A product or service is defective if it fails, in some respect, to conform to specifications or a standard. For example, customers like invoices to be correct. If you charge them too much, you will definitely hear about it and it will take longer to get paid. If you charge them too little, you may never hear about it. As an organization, it is important that your invoices be correct. Suppose you have decided that an invoice is defective if it has the wrong item or wrong price on it. You could then take a random sample of invoices (e.g., 100 per week) and check each invoice to see if it is defective. You could then use an np control chart to monitor the process.

You use an np control chart when you have yes/no type data. This type of chart involves counts. You are counting items. To use an np control chart, the counts must also satisfy the following two conditions:

1. You are counting n items. A count is the number of items in those n items that fail to conform to specification.
2. Suppose p is the probability that an item will fail to conform to the specification. The value of p must be the same for each of the n items in a single sample.

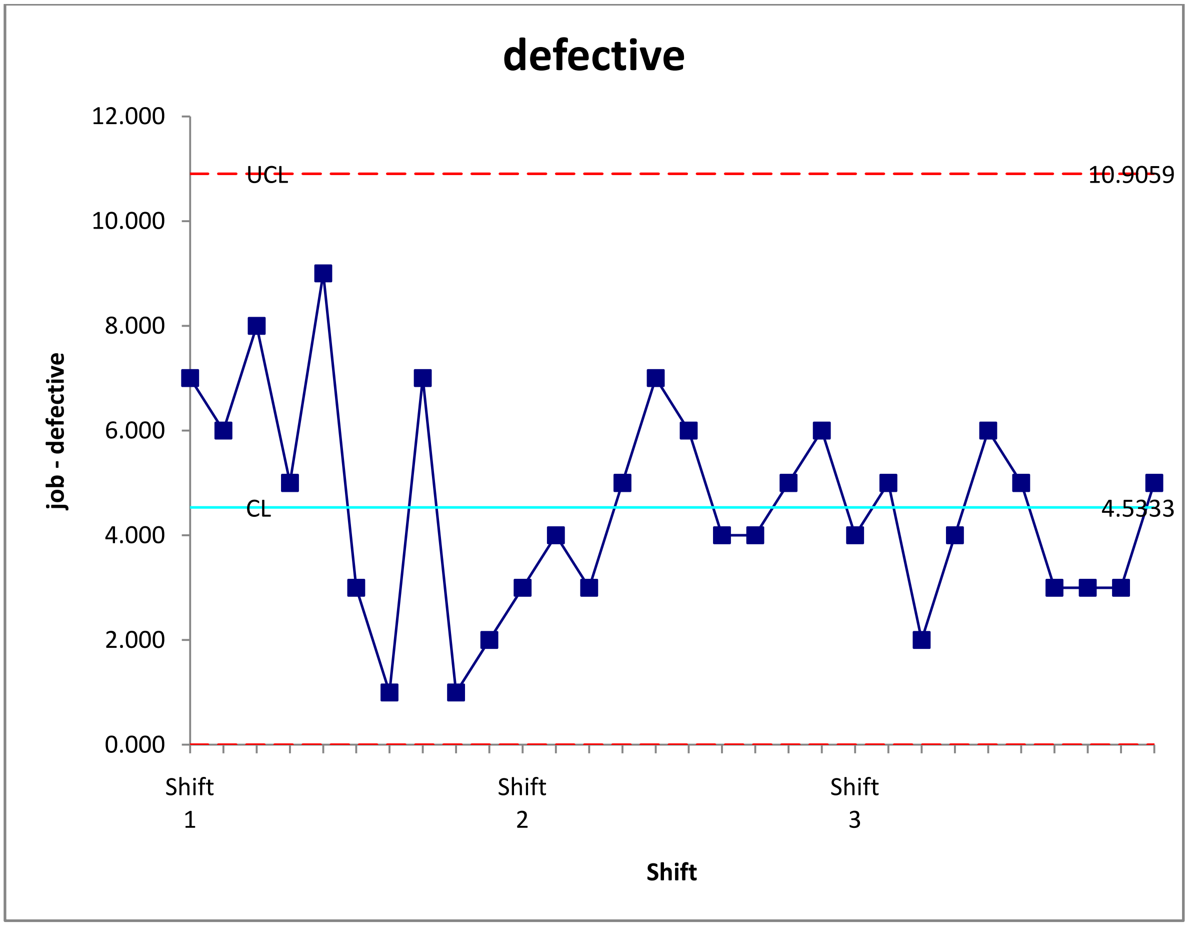
If these two conditions are met, the binomial distribution can be used to estimate the distribution of the counts and the np control chart can be used. The control limits equations for the np control chart are based on the assumption that you have a binomial distribution. You can't use the p control chart unless the probability of each shipment during the month being on time is the same for all the shipments. Big customers often get priority on their orders, so the probability of their orders being on time is different from that of other customers and you can't use the p control chart. If the conditions are not met, consider using an individuals control chart.

6.4 Control charts for bad Flute

Table no. 2 Bad flute data

Shift	Date	Job	Defective	Fraction defective
Shift 1	16/2/2017	970	7	0.007
	18/2/2017	886	6	0.007
	19/2/2017	930	8	0.009
	20/2/2017	759	5	0.007
	21/2/2017	1130	9	0.008
	22/2/2017	1250	3	0.002
	23/2/2017	1123	1	0.001
	25/2/2017	990	7	0.007
	26/2/2017	1393	1	0.001
	27/2/2017	1392	2	0.001
Shift 2	16/2/2017	1605	3	0.002
	18/2/2017	1706	4	0.002
	19/2/2017	1394	3	0.002
	20/2/2017	1430	5	0.003
	21/2/2017	1456	7	0.005
	22/2/2017	956	6	0.006
	23/2/2017	895	4	0.004
	25/2/2017	1637	4	0.002
	26/2/2017	793	5	0.006
	27/2/2017	730	6	0.008
Shift 3	16/2/2017	1490	4	0.003
	18/2/2017	1558	5	0.003
	19/2/2017	1557	2	0.001
	20/2/2017	1543	4	0.003
	21/2/2017	1790	6	0.003
	22/2/2017	1635	5	0.003
	23/2/2017	1537	3	0.002
	25/2/2017	1703	3	0.002
	26/2/2017	1297	3	0.002
	27/2/2017	1594	5	0.003
Total		39129	136	

Chart 2: np control chart



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7. COUNTER MEASURE ACTION FOR SIGNIFICANT ROOT CAUSES

Sr. No.	**Significant root cause**	**Counter measure plan**
1.	Steel OD suiting is not done to carbide ID	Individual pieces of steel & carbide to be suited with 0.15 mm brazing gap Train the operators on measurement Release SOP for measurement of steel OD and carbide ID
2.	Centre formation in lathe	Include center formation in lathe as process step Display One Point Lesson (OPL) showing the right and wrong practices Include the instructions in SOP
3.	Centre lapping not done	Center lapping part of process steps Include the instructions for centre lapping in SOP
4.	Blank holding problem	Arrangement of proper collet of all sizes to the m/c Arrangement of small sizes Ejector to fluting (below 3.00 mm)
5.	Under size blanks	Reconditioning of CIN 3 , 4, & 6 no's m/c Control chart to be implemented
6.	Improper setting.	Tooling & Setting SOP to be implemented Control charts to be implemented Operators skill up gradation
7.	M/c run idle	Hopper problem of hertlein m/c to be rectified
8.	Guide bushing is not proper	Arrangement of proper Guide Bush to all fluting m/c

8. CONCLUSION

After Inspecting the problems related to bad flute and damage rejection of drills and Implementing the countermeasure plans on the priority causes of problems the defect occurring while manufacturing the drills have reduce and productivity of industry shall increase. Increase in productivity results in decrease in manufacturing cost and optimum utilization of resources and improved quality of product. Also this have helped us by providing knowledge about the present manufacturing technologies and management in organization.

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