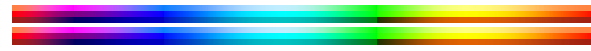


**TESSERACT**  
Management Systems



## **GUIDELINES**

# **Problem Solving Tools and Techniques**

Prepared by:

**Mike Clargo**

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## INTRODUCTION

This document is intended to provide a basic outline of the most common tools that are required to support the problem solving process. The guide can be used stand-alone to support isolated uses of individual tools, but is best used in conjunction with Tesseract's guide to the P.R.O.B.L.E.M. model for problem solving.

The structure of this guide is as follows:

<b>1. BRAINSTORMING</b>	<b>3</b>
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<b>3. CHECKSHEETS</b>	<b>6</b>
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# 1 BRAINSTORMING

Brainstorming is a technique used in a group situation to enable participants to generate as many ideas about a situation as possible, in as short a time as possible.

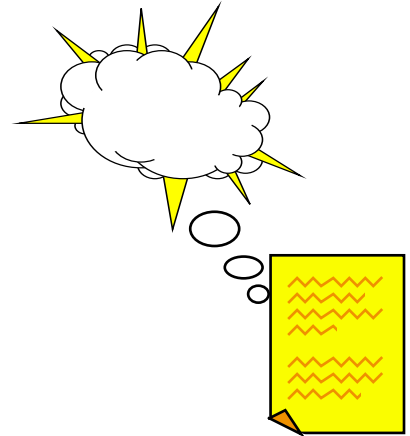
A successful brainstorming session will promote creativity, create excitement and motivation, reduce 'boundaries' and help develop commitment.

There are two ways in which a brainstorm can be used, either:

- structured - where everyone in the team is asked to contribute an idea in turn, passing if they dry up, until everyone has exhausted their ideas, or
- unstructured - where everyone in the team just shouts out their ideas as they occur to them, again until everyone has exhausted their ideas.

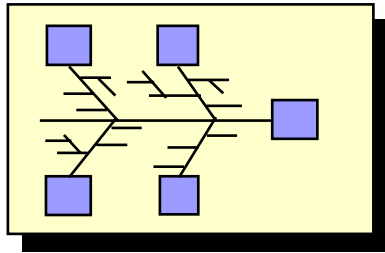
Either way, the basic rules and guidelines are the same:

- clearly state the issue under consideration
- identify one person to record all the ideas on a flipchart,
- keep the flipcharted comments visible to all
- a group of four to ten people is optimal
- avoid judgment or criticism of the ideas, either verbal or non-verbal
- avoid any discussion or evaluation of the ideas (during the brainstorming process)
- encourage complete freewheeling and ideas association, 'silly' ideas are just as valid
- all ideas are recorded, without interpretation
- encourage people to build on the ideas of others
- generate as many ideas as possible
- everyone should have an equal opportunity to contribute
- IT SHOULD BE FUN





## 2 CAUSE AND EFFECT ANALYSIS



The Cause and Effect Diagram (also known as a 'Fishbone Diagram' or 'Ishikawa Diagram') is a technique for clearly presenting a brainstormed list of possible causes having an effect on a particular situation.

Most problems are likely to have more than one root cause and to ensure a permanent fix it is important that all these possible causes are identified. The Cause and

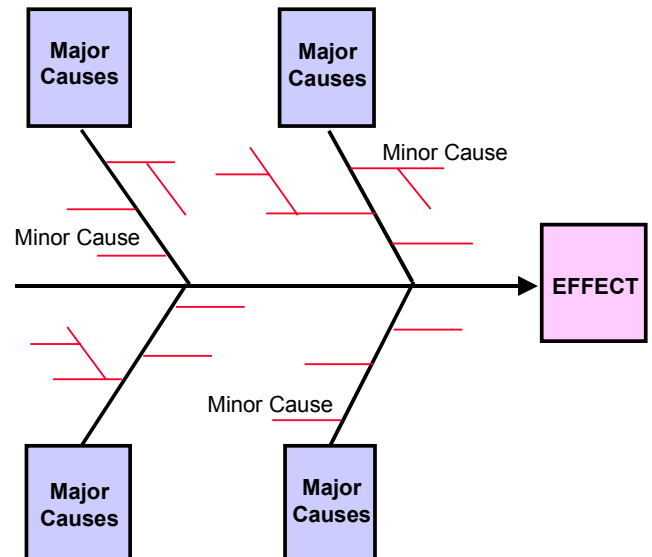
Effect Diagram is a way of combining an analytical process with the creativity of brainstorming to help see all the alternatives.

The technique is usually used in a team situation, but can be effectively used by an individual, to begin to break down what can, at first sight, seem to be an intractable problem. In this way, large problems or effects may be broken down into more easily manageable sizes for more analysis.

A completed Cause and Effect Diagram can tell a number of things. It is possible to see, at a glance, how thoroughly the problem has been investigated by the amount of information on the Diagram. A relatively bare diagram would indicate that either insufficient effort has been put in to identify possible causes, or that the problem is not really significant in the first place. If the Diagram is comprehensive it can help highlight potentially important or hitherto undetected relationships between possible causes.

### Steps:

1. Place the name of the problem or effect in a box on the extreme right of the diagram and draw one line pointing into this box. (If using A1 flipchart remember to use it in landscape orientation!)
2. Decide on the main categories of major causes, placing these in boxes above and below the line, but some distance from it. Then connect the cause boxes to the main line with slanting lines.
3. Brainstorm for possible minor causes and add them to the diagram, with sub-divisions if necessary, on the line from the major cause to which they relate.





### Deciding on the main categories:

This can be achieved in one of three ways:

- Brainstorming
- the 4M's - Manpower, Machinery, Materials, Methods
- the PEMPEM approach - Plant, Equipment, Materials, People, Environment, Methods

The number of Major Causes is not limited in any way, but for the diagram to be useful should exceed three and not be too many so as to make it unreadable.

### Identifying the Minor Causes:

Follow the strict rules of brainstorming to complete the diagram. This can be done in two ways, either

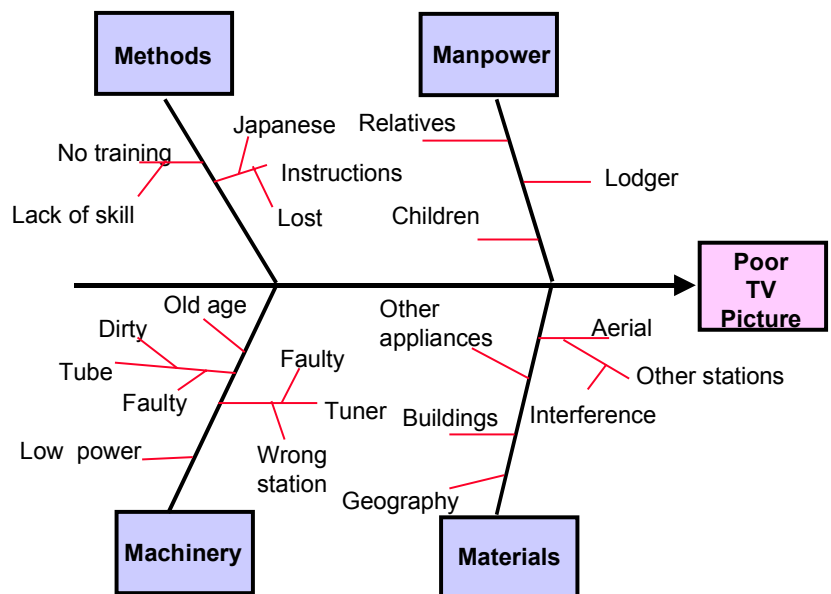
- randomly - where ideas can be identified which apply to any of the Major Causes categories, or
- systematically - where ideas can be generated down each of the Major Cause 'bones' in turn. As with brainstorming, allow time for further ideas to incubate.

### Tips:

Use large diagrams in a team situation, so that all members can see what is going on.

Do not overload any one diagram. If a Major Cause is getting 'full', consider making it the subject of a diagram of its own.

Look for multiple occurrences of the same minor cause or logical relationships between causes to help identify the probable root causes.



### Selecting the Most Likely Causes:

A Cause and Effect Diagram will help clarify a situation but alone will not 'identify' the root cause, only help suggest areas for data gathering and further analysis.

Identifying the root causes will be a matter of evaluating the causes one-by-one until they are found, but discussion of the cause and effect diagram may help you to select the best places to look for the root cause.



### 3 CHECKSHEETS

A Checksheet (Tally Chart, Tick Chart) is one of a variety of tools used to simply record data, usually in the form of the number of times something happens, helping to detect patterns in the occurrences.

Checksheets are particularly useful when more than one person is involved in the collection of the data, ensuring consistency in the data recorded and its presentation.

The exact design of the chart used will be specific to the type of data being gathered and the purpose for which it is being gathered.

#### Steps:

1. Decide on what data needs to be gathered to be able to show up ant patterns, and if the data can be analysed to give any useful information.
2. Design a form which will make the collection of the data easy and clear.
3. Test the sheet with someone who was not involved in the design to check that it can be used, and modify it if necessary.
4. Design a separate master tally chart to combine all the data from all the other tally charts being used to gather the data.
5. Gather the data

#### Tips:

Talk to those doing the job when designing a chart to gather data about it.

Make sure all data collectors are clear about **what** data is being collected and **why**

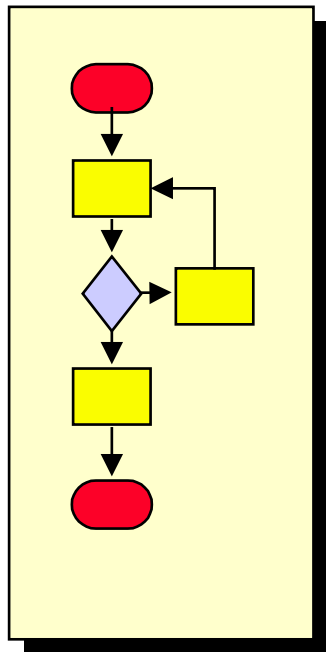
Type of Complaint	Tally	Total
Product Defect		14
Service		6
Billing Error		2
Shipping Error		8
Totals	30	

Work station	Defective Items	Monday 23/6
A	111	8
B		10
C	11	2
D	1	16
E	1	6

Work station	Defective Items	Tuesday 24/6	Totals
A	11	7	
B	1	6	
C	111	3	
D	1	11	
E	111	8	






## 4 FLOWCHARTS

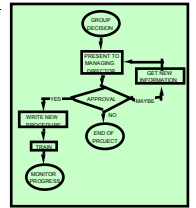


A Flowchart is a pictorial representation of the steps involved in a particular process. It can be as simple or as detailed as you like, depending on the reason for drawing in the first place.

### Steps:

There are a number of standard symbols used in a flowchart to represent particular parts of the process:

-  the start (or end) of the process
-  an activity, task or step in the process
-  a decision point, with 'yes' being straight out of the lower point and 'no' off to the right or left



Lines with arrowheads are used to link the elements, to show the flow of the process.

Although a flowchart may be drawn up by an individual, it is best used as a team activity. The team should consist of those people who really know the process being analysed, ie those actually involved in *doing* it, regardless of hierarchy.

1. Define the boundaries of the process, ie where you are going to start from and where you will finish.
2. Identify **all** the tasks or activities which constitute the process - to a level of detail which makes sense for the understanding you need.
3. Place the activities in chronological order, with concurrent activities next to each other.
4. Ensure all feedback loops to previous parts of the process are in place.

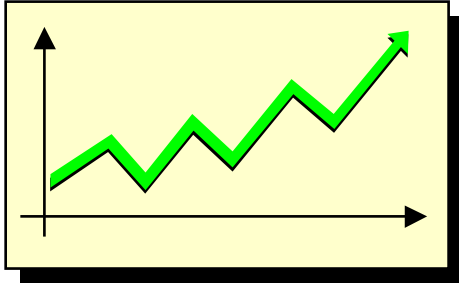
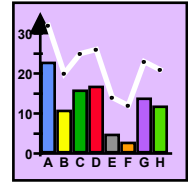
### Tips:

- define the boundaries of the process very clearly
- keep the symbols simple
- draw the process as it is in reality, not how you think it ought to be
- if more than one arrow comes out of a 'task' box, consider using a 'decision' diamond
- check the validity of the flowchart at regular intervals with others involved in doing the process



## 5 GRAPHS AND RUN CHARTS

Graphs and run charts are forms of data display. They allow you the possibility of see relationships and/or trends in data much more clearly, enabling a large amount of data to be seen together.



Graphs show a relationship between two measured variables, changes in one of which affect the other. Thus you have an independent variable and a dependent variable. As the value of the **independent** variable changes, plotted on the 'x'-axis, you measure and plot, on the 'y' axis, the effect it has on the value of the **dependent** variable.

### Steps:

1. Decide on the variables, draw the axes and label them.
2. Decide on the scale to be used, based on an estimation of the performance of the variables. The scales do not have to be the same for each axis, but should be chosen to be as large as possible to allow a reasonable 'picture' to be seen.
3. Plot the points on the graph using the pairings of measurements as the co-ordinates.
4. Join the points with straight lines to see the 'picture' of the data.

A variation of this tool is the 'smoothed' graph. In this case, the data plotted is an average of the values of the dependent variable over a group of measures of the independent variable. In this way, trends become more obvious as extreme peaks and troughs are smoothed out.

The 'run chart' is a specific kind of graph, where the 'x'-axis is **time**.

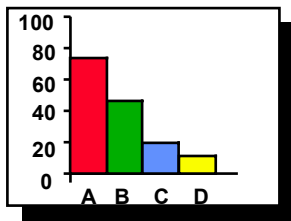
Thus the data is gathered on a time-related basis and plotted in such a way as to show what happens as time progresses. It is, therefore, important in this case to ensure that the data is plotted in the order in which it is collected.

Due to the nature of this type of graph, more specific interpretation is possible. Any changes in the performance (output) of the process being graphed will be shown as a *run* of measurements.



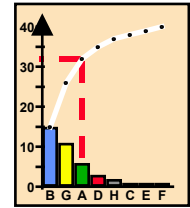


## 6 PARETO ANALYSIS



This data display technique goes under a variety of names. As well as 'pareto' it is known as 'the 80/20 rule' and 'the vital few versus the trivial many'

In simple terms, this tool is a bar chart with the variables under consideration being ranked in order of frequency of occurrence, from the highest to the lowest.



The 'pareto principle', said to be named after an early Italian researcher who discovered that 80% of the nation's wealth was held by 20% of the population, hypothesises that 80% of a situation can be accounted for by 20% of the variables. This is only a general principle and is rarely exact, but it does allow for some concentration of effort on the 'vital few' contributors - ie for more data to be collected.

### Steps:

1. List the variables being analysed in order of magnitude, starting with the largest.
2. Draw a bar chart, with the frequency of occurrence of each successive variable on the 'y'-axis and the variable itself on the 'x'-axis.
3. Draw in the cumulative curve by adding the values of each successive variable together, ie the largest to the next largest and so on.
4. Add a scale from 0% to 100%, running from the 'x'-axis to the top of the cumulative curve.
5. Where the 80% level intersects the cumulative curve, read down to the 'x'-axis to identify the 'vital few' variables .

### Example:

A checksheet of queried invoices looks like:

Error	Frequency
Wrong items	5
Short shipped	12
Wrong price	27
Illegible	3
Part order	1
Unwanted items	4
Damaged items	9
Total	61

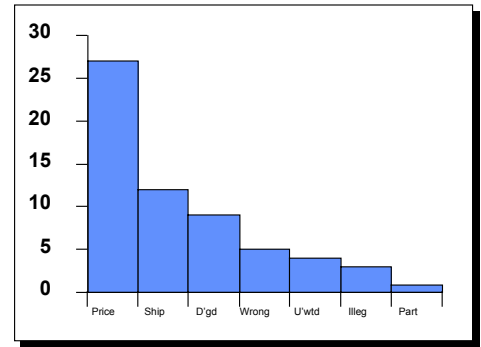
When ranked in frequency of occurrence it becomes:

Error	Frequency
Wrong price	27
Short shipped	12
Damaged items	9
Wrong items	5
Unwanted items	4
Illegible	3
Part order	1
Total	61



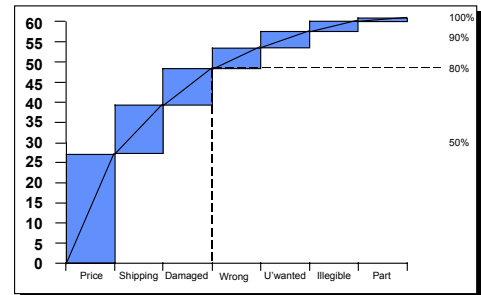
As a bar chart, this becomes:

Each variable is drawn on the chart in decreasing order of frequency of occurrence.



Adding each of the variables' frequencies together and including the cumulative curve gives:

What this now shows is that the three causes of queried invoices - wrong price, short shipped orders and damaged items - are the three areas to concentrate effort on in terms of gathering more data and/or reviewing the relevant elements of the overall process.

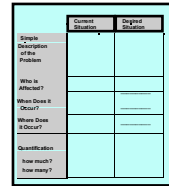


### Tips:

Pareto doesn't immediately identify the specific solution, it focuses attention on areas worthy of more data gathering.



## 7 PROBLEM DEFINITION SHEET



The Problem Definition Sheet is a tool for developing your understanding of the problem that is to be addressed.

In essence it is a simple table requiring the team to outline their understanding of the who, what when, where, how of the situation, both for how it is now, and how they want it to be in the future.

By driving down to specifics, the Problem Definition Sheet does much to drive out basic misunderstandings and hidden agendas.

The actual layout of the Problem Definition Sheet is shown below:

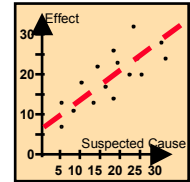
	Current Position?	Wanted Position?
<b>What is the problem?</b>		
<b>Who is affected?</b>		
<b>How are they affected?</b> How much/ often/long?		
<b>When does it occur?</b>		
<b>Where does it occur?</b>		
<b>Why is it important?</b>	<b>Costs:</b>	<b>Benefits:</b>

### Steps

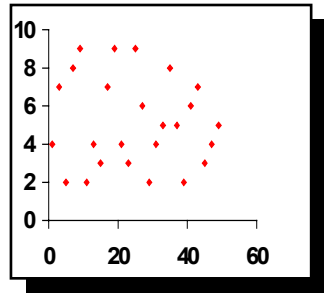
1. Start with the left hand column
2. Outline clearly the teams understanding of: the current problem; who is affected by it; quantification of how they are affected; when the problem arises; where the problem arises; and the cost implications of the problem.
3. The team should seek to reach common agreement on all these points, and should gather data to resolve disagreements. Every attempt should be made to depersonalise the data in order to keep the process objective.
4. The team should then work through the right hand column, and outline their vision for solving the problem: what the final situation should be; who will benefit from it; how they will benefit; when they will benefit; where those benefits will arise; and the financial expectations of those benefits.



## 8 SCATTER DIAGRAM



A Scatter Diagram is a tool to establish whether or not a causal



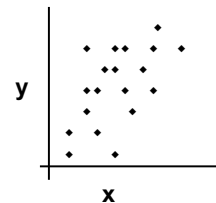
relationship exists between two variables. It cannot prove that one variable causes the other, only whether or not a relationship exists between them and the strength of that relationship.

Paired measurements are taken and the data plotted on a graph. Conventionally, the possible cause - the independent variable - is plotted on the horizontal axis, whilst the possible effect – the dependent variable is plotted on the vertical axis.

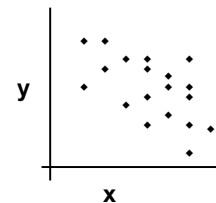
The picture created by the points plotted gives an indication of the nature of any relationship between the variables.

### Steps:

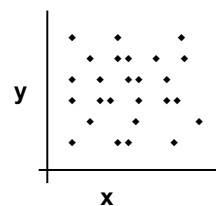
1. Collect plenty of paired data.
2. Plot on the graph.
3. If required, estimate or calculate the line of best fit (a statistical calculation to establish the exact degree of correlation - but beyond the scope of this module).



Possible positive correlation between the variables (as 'x' increases, so does 'y')



Possible negative correlation between the variables (as 'x' increases, 'y' decreases)



No correlation (the value of 'y' is not dependent on the value of 'x')

### Tips:

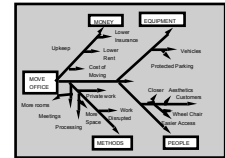
Always gather lots of pairs of data (between 50 and 100 points gives good results).

Interpret the diagram with caution - other factors may be influencing the results.

A scatter diagram can only tell you if two variables are related in some way, not that one *causes* the other



## 9 SOLUTION EFFECT DIAGRAM



The solution effect diagram is also known as the backwards fishbone. This is mainly because that is exactly what it is – the graphic or diagram is the reverse of the normal fishbone diagram (Cause & Effect Diagram, Ishikawa Diagram – see Section 3), and the nature of how it works is the reverse also.

The Solution Effect Diagram is used for evaluating the effects, knock-on effects, and implications of a possible solution. This tool helps teams to think through the likely consequences of a preferred course of action before they commit to it.

### Steps

1. Draw on a large sheet of paper (e.g. flipchart), oriented landscape, a long horizontal line across the middle.
2. At the left hand end of this line draw a large box, and write in it the solution that is to be evaluated
3. As with the fishbone diagram of section 3, draw diagonal lines coming out from the central line. In this case there should be 4-6 lines, 2-3 coming up and to the right, and 2-3 coming down and to the right
4. Place boxes on the ends of these lines and label them with the major areas that might be affected by the solution. As with the Cause & Effect diagram these could be brainstormed, or the 4M's - Manpower, Machinery, Materials, Methods, or the PEMPEM approach - Plant, Equipment, Materials, People, Environment, Methods
5. Brainstorm with the team all the possible implications for the solution in these various areas, and write up the suggestions on the various lines.
6. When the brainstorming has finished, review the diagram and circle those suggested implications which the team considers to be serious - in terms of likelihood or impact. In the event that it is decided to proceed with the solution this will guide the team in thinking through improvements or contingencies to their solution.



## 10 SOLUTION MATRIX

Criteria \ Alternatives	Cost	Time	R.O.I.	Total
Buy press	4	4	1	9
Recondition	3	3	2	8
Do nothing	2	1	4	7
Contract out	1	2	3	6

The solution matrix is a selection tool for guiding the team to make choices between potential solutions.

The matrix works by comparing solutions (listed by row) against a number of clearly defined selection criteria (listed by column).

The matrix is intended to guide selection by forcing an exploration of all of the facets of each solution. As such it will give an indication of how the choice should be made, but this should be agreed by the team. The team should not use the tool to choose a solution 'mechanically'.

The tool can be used with varying degrees of sophistication. The simplest form is outlined below:

### Steps

1. List the solution options in the left hand column – one per row
2. In the headings of the other columns write down the selection criteria you will use – the most common are: impact of solution, ease of implementing the solution, likelihood of success.
3. For each of the proposed solutions, rank it on a scale of 1 to 3 (where 3 is good) under each of the criteria
4. Add up the scores for each solution and discuss the result to make your choice

### Modifications

The following are possible enhancements you might consider, individually or combined:

- Choose a wider range of selection criteria, probably based on the project objectives
- Widen the scale for ranking the solutions to 1-5 (1-10 could be used but often ends in futile debates)
- Weight the importance of the selection criteria relative to each other (on a scale of 1-5) and use this to modify the overall result by multiplying the ranking of the solution by the weighting of the criteria

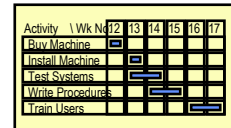
Or the model could be simplified in some situations by using ticks against the criteria.

### Note

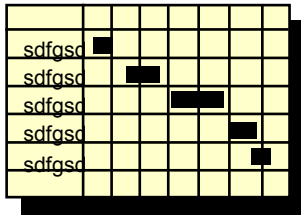
It is very important that none of the criteria use should be a disqualifier (e.g. if the solution did not meet it could not be used). Disqualifiers overwhelm the results of the selection matrix and should be used as a coarse filter on the solutions before they reach this selection stage. There is no point in ranking a possible solution against others if it is clearly a 'dead duck'.



## 11 GANTT CHARTS



A Gantt chart is a simple aid to action planning. It is a time based chart on which all the actions involved in achieving a plan are illustrated.



It helps identify and control activities and their interdependencies, allowing team members to be aware of, and monitor, progress. A Gantt chart is an integral part of Project Planning, where it helps identify much more detail about the progress of a project plan.

### Steps:

1. Identify all the major tasks involved in the project being undertaken.
2. Carefully consider the likely duration of each of the tasks.
3. Establish the overall project deadline.
4. Create a chart with timescales across the top and the tasks, in chronological order, down the side.
5. Represent the duration of each task by a horizontal bar across the chart, indicating its start and finish time.
6. Use as a guide to monitor progress of each separate task and the likelihood of completing the overall project on time.

### Example:

To develop and implement a new training programme a number of tasks have to be completed over a period of time, ranging from establishing the need through to running the first course. A Gantt chart to illustrate and control this as a project could look like the one below.

