TOOLS, TECHNIQUES AND APPROACHES USED IN OUR

VALUE IMPROVEMENT AND YIELD OPTIMISATION PROGRAMMES – QUIKSHOT & VIYOP

This glossary presents terms in alphabetical order. Where a term has a Japanese origin, it will be covered under its English equivalent with a link between the original Japanese term and its English equivalent. Defined terms are emboldened.

3Es	developed as part of the UK Government's Best Value approach – an improvement activity for local government. The **3Es** refers to the key drivers in achieving best value. They are **economy, efficiency** and **effectiveness**. Each of these terms is defined in more detail within this glossary. There are other definitions of the **3Es**, most of them include **efficiency** and **effectiveness** but replace **economy** with other parameters.
5Ss	a basic tool set within Kaizen concerned with creating a standardised and orderly workplace. It is sometimes translated into the 5Cs, but the translation fit is a bit flaky! The **5Ss** are *Seiri* – sort or clear out and only retain what is needed; *Seiton* – straighten or configure the workplace to create a place for everything; *Seiso* – scrub or clean and check that everything is clean and in its place; *Seiketsu* – standardise or conform to ensure that the first three of the 5Ss become part of the daily work system; *Shitsuke* – self-discipline or care, taking personal responsibility for living up to the previous four Ss.
5 Whys	is a problem definition approach that seeks to move from superficial causes to root causes by asking why – five times. The logic is that each answer to 'why?' reveals a more fundamental cause, and experience has shown that after asking five times that the final answer is the root cause. It follows that eradication of the root cause will have a disproportionate positive effect on the final solution.
6 Thinking Hats	an approach to problem solving developed by Edward de Bono. Each hat describes a different mental state required to solve problems, and provides a mechanism to use appropriate mental states at different stages of the problem solving process. The white hat is neutral and objective and is concerned with objective facts and figures. The red hat is concerned with feelings and gives the emotional view. The black hat is sombre and serious and is concerned with critical evaluation. The yellow hat is sunny and optimistic and concerns hope and positive thinking. The green hat represents growth and is concerned with creativity and new ideas. The blue hat is concerned with control, the organisation of the thinking process and the use of other hats.
7 management planning tools	these are generally more sophisticated than the **7 statistical tools**. They are **affinity diagrams, interrelationship diagrams, tree diagrams, prioritization matrices, matrix diagram, process decision programme chart**, and **activity network diagram**. Each of these is described in a little more detail within this glossary.

7 statistical tools	these are designed to be used by individuals and work groups in helping to define and solve problems/realise opportunities. They are **Pareto diagrams, cause and effect diagrams, histograms, control charts, scatter diagrams, graphs,** and **checksheets**. Each of these is described in a little more detail within this glossary. The **graphs** referred to are simple representational graphs including bar graphs, time sequenced line graphs, pie charts and radar charts.
80/20 Rule	see **Pareto Principle/Diagram**.
Activity Network Diagram	one of the **7 management planning tools**, originally termed "arrow diagram". It is a tool to plan how a complex task is to be scheduled and completed and has evolved from Programme evaluation and review technique (PERT), the **Critical Path Method** (CPM) and the related **Critical Path Analysis** (CPA). Now widely available in standard software including Microsoft Project.
Affinity diagram	also known as the KJ method after its originator Jiro Kawakita. The affinity diagram brings together a large amount of language-based data and organises that data into groups that are linked and share a common theme. The choice of that theme is determined by the group and enables complex data to be simplified as a result of generating a level of shared understanding. It is a creative sense making process, rather than a logical one determined by external immutable criteria.
APQP –Advanced Product/Process Quality Planning	this is an approach to design of either a product or process that seeks to ensure that the design outcome is both capable and robust. Developed in the automotive industry, it is a highly structured approach that identifies each stage of the design process, required inputs, stage processes and appropriate tools, and outputs. The emphasis is on clear definition of customer needs, assurance that solutions are capable, and that risks have been identified and designed out.
Arrow diagram	see **Activity Network Diagram**.
Autonomation	is the Anglicisation of the Japanese term **Jidoka**. It describes a type of machine designed to stop automatically whenever a problem occurs. The philosophy lying behind this approach is that it is better to stop an activity and solve the problem, rather than get by and live with a continuously occurring problem – a situation that is seriously aggravated by automation where a defect may be quickly proliferated
Belts	a system of classification of practitioner competence used within **Six Sigma**. There are three levels of belts - yellow, green and black. A black belt is a master practitioner and major change agent, a green belt can run projects independently, and a yellow belt forms part of a six sigma team.

Benchmarking	an approach first developed within value management /value engineering to establish how different products realised desired functions and at what cost. It has been developed to become the systematic comparison of organisational or product processes and performance in order to both establish challenging performance standards and identify ways of working that enable those performance standards to be realised. Benchmarking may be undertaken internally or externally, it may be focused on close competitors or it can consider similar processes in quite different contexts. It is often difficult to establish benchmarks that are directly comparable, and can often result in denial – it doesn't apply to us – we're different. Rather than see it as a prescriptive approach to setting standards and learning from others, it is perhaps better seen as an approach that identifies improvement opportunities and potential ways to realise those opportunities.
Brainstorming	the most popular and frequently most misused approach to idea generation is part of creative problem solving. To be effective, the problem that needs to be solved should have been defined. Brainstorming then aims to generate new ideas by encouraging freewheeling and thinking "outside the box". To do this it has a set of simple rules – go for quantity not quality, be prepared to evaluate apparently silly ideas, and criticism of ideas is not permitted; find positive elements in other people's ideas and build on them. Failure to follow these rules generally results in a small number of already known solutions – which do not add to the problem solving potential of the team.
Causes of variation	causes are divided into 'natural' and 'special' causes. The distinction is critical in improving performance. A natural cause is one that is inherent in the process, and a process only displaying natural causes will be in statistical control – its results will be predictable – but not necessarily acceptable. Special causes result in the process behaving in an unpredictable way. Different approaches are adopted to deal with natural and special causes. As a generalisation, processes are protected from special causes either by seeking to make them insensitive to them or by controlling the special cause so that its impact is limited. Big gains in process capability are achieved through identifying the key natural causes of variation and then establishing controls that limit the variation.
Cp Index	see **Capability**
CpK index	see **Capability**

Capability	is the ability of a process to achieve a desired result based on performance data. It is normally measured as a **Cp Index,** which relates the inherent variability in the process to the acceptable range of output values (the process width). The statistical measure is the upper specification limit, less the lower specification limit divided by six times the standard deviation of the process (which measures inherent variability) or USL-LSL / 6 σ. The higher your Cp Index the more capable your process. However, it is possible to have a capable process where the range of outputs is not centred in the middle of the desired process width. The **CpK Index** adjusts for this, taking into account how the distribution of results lies around the middle of the process range.
Cause and Effect Diagram	this diagram seeks to analyse the characteristics of a process and the factors that contribute to them. Cause and effect diagrams can come in a number of forms. The two most frequent are the Ishikawa or fishbone diagram, and the **5 Whys**. The "fishbone" diagram provides a skeleton, often of four basic categories of causes – machine, method, material and people, and teams identify causes under those four headings. The **5 Whys** is more flexible and refined, in that it leaves the team free to select causes and then uses a repeated questioning technique (asking "why did this happen") to establish root causes.
Checksheets	one of the **7 statistical tools**. It is a simple proforma to capture the frequency of an event or series of events or parameters within specified time periods. It provides facts rather than opinions, and creates the base for subsequent analysis and decision making. Although simple, the key is to ensure that data is being collected on the appropriate parameters and that they are defined so that characterisation of the event/parameter can be consistently applied.
Collaborative Planning	is a critical element in lean project management. It is based on the precept that traditional planning methods, using a professional planner and based on experience, inevitably operate above the fine level of detail and as a consequence often unintentionally embed wasteful practices. Collaborative planning, by undertaking planning with the people who will make it happen, can reveal those wastes and establish plans that enable them to be removed. Collaborative planning claims to reduce lead-time and rework and improve plan reliability. A comprehensive approach to collaborative planning has been developed and patented and is known as 'The Last Planner System'.
COPQ – cost of poor quality	a financial measure of how much failure to adhere to specification costs an organisation. For organisations that have not actively sought to improve the capability of processes, COPQ is often estimated to be in excess of 15% of operating costs.

Control limits/charts	control limits show the natural cause variation of a process. By convention, they are set at ±3 standard deviations, and at that level 99.73% of natural variation will fall within the range created by the upper control limit (UCL) and lower control limit (LCL). Control limits should not be confused with acceptable quality limits or specification limits. The natural variation of a process may be greater than the desired performance – it therefore lacks capability. A control chart is a run chart showing results over time with the arithmetic mean and LCL and UCL superimposed. This enables you to see results or trends indicating special causes and take timely corrective action.
CTQ – Critical To Quality	a concept used in **Six Sigma** to describe key customer requirements. They help describe a problem from the customer's perspective, and are the basis of performance measures used both to define the problem & set targets and to determine whether outcomes are adequate.
CTQ Tree – Critical To Quality Tree	this is a tree diagram that structures customer wants and needs in progressive detail, which result in specific requirements defined by measurable characteristics. It is very similar to a value tree. The essential difference is that in a value tree you would define wants and needs from the critical stakeholder perspectives (might not be quite the same as the customer perspective), and you would also understand the relative importance of wants and needs so that you could understand the impact of any change on perceived value.
DoE – Design of Experiments	is a way of determining and measuring the importance of multiple factors on the outcome by experimenting with many factors and variables simultaneously. It uses sophisticated statistics (which you do not need to understand) to substantially reduce the number of tests or experiments you need to undertake. DoE enables you not only to understand which are the most important variables, but also to model how changes in their performance will impact on desired outcomes. The two most popular approaches to DoE are one developed by Dorian Shainin, and the other by Genichi Taguchi. In common with many sophisticated methods, they are only as good as the inputs, and it is critical with DoE that there is sufficient understanding of the process that all key variables are identified and included in the experiment.
DMAIC – Define, Measure, Analyse, Improve, Control	is the acronym that represents the five phases of the **Six Sigma** methodology – the **Six Sigma** problem solving sequence. It is a logical sequential process and shares much of the logic to be found in a range of problem solving methodologies. The phase descriptions may be changed but many of the underlying activities are common.
DRIVE	is the acronym used within Npower to describe its approach to CI. It covers define, review, improve, verify, embed as the five stages of its CI process. These stages cover the same ground as the PDCA or DMAIC CI processes.

Deming Cycle – Plan, Do, Check, Act (PDCA)	represents a four-phase approach to problem solving/process improvement. *Planning* involves analysis and definition of the problem and the creation of an improvement plan. *Doing* involves application or implementation of that plan. *Checking* entails ensuring that desired improvements have been achieved. *Acting* entails ensuring that the new approach is institutionalised and becomes the new standard of performance. It shares many aspects with the Six Sigma DMAIC problem solving sequence but with different emphases.
Design to cost and performance	this is often described as a *market price minus* as opposed to a *cost plus* approach. In essence it is argued that market forces largely determine required levels of performance and a related selling price. It follows that a successful design must not only meet performance requirements but must do so at a cost that will enable a market selling price to be established that generates adequate profit to justify the investment. Design to cost and performance requires more care to be taken in arriving at a performance specification and being clear about cost constraints. If this care is not taken, there will not only be more design iterations but the risk of failing to identify and meet customer performance requirements will increase as performance becomes sacrificed to meet cost consideration.
Economy	a term used within the **3Es** to describe procuring a process input at lowest cost consistent with meeting minimum required performance standard of that input.
Effectiveness	a term used within the **3Es** to describe how well process outputs results in outcomes that are valued by the customer. A process can be efficient but not effective, and vice versa.
Efficiency	a term used within the **3Es** to describe how well a process converts inputs into desired outputs.
FMEA – Failure Modes Effects Analysis	is a risk management tool that can be used both in design and in operation to prevent potentially undesirable outcomes – *failure modes*. It is based on understanding the required function of a product or process and identifying what could go wrong – the failure modes, and then assessing those failure modes from three perspectives. The severity of effect if it did occur; the probability that a failure would occur; and the probability that the failure would be detected before the effect was experienced. Each parameter is rated on a scale from 1 to 10, and the parameter scores multiplied to give a risk process number (**RPN**) with a potential score of 1000. The higher the score, the more important it is to resolve the problem. It can be applied to a product or process in the design phase, or used during operations to prioritise improvement actions.
Fool-proofing (also known as Poka –Yoke)	this is a process design approach that seeks to ensure that defects are prevented or made obvious, so that they do not move to the next process stages where the cost impacts become increasingly expensive. The spell checker in Microsoft Word is an example of a fool-proofing approach.

Function	within Value Management, a function describes what a product, service or process must do to be able to work and be chosen by the user. There is a relationship between needs and wants that are translated into performance objectives, and functions that are required to realise those performance objectives. That relationship lies behind the concepts of **functional performance specification** and **design to cost and performance**.
Function Analysis	is a process where the functions required to satisfy a user are identified, and the contribution that each function makes to user satisfaction is established and compared with the cost of providing the function. The analysis can identify four classes of value mismatch – user needs not recognised, user needs not adequately met, user needs met but at an unacceptable cost and cost incurred without value to user. Each result in a focus to redesign the product, service or process to better meet user needs.
FPS - Functional Performance Specification	a structured process to generate a product, service or process specification that seeks to identify required performance outcomes, establish the relative importance of those performance outcomes , and understand the relationship between performance levels and cost. It is believed that such a specification establishes a performance, and cost envelope within which the designer has freedom to develop design options that maximise value. The use of FPS is an important element in a **design to cost and performance** approach.
Gauge R+R – Gauge reliability and reproducibility	it is important that any measurement regime can provide measurements that can be relied upon. Gauge reliability and reproducibility studies seek to provide a key element of reliance. If measurement is to be relied upon, it is generally accepted that variation inherent in the measurement system should account for no more than 10% of the specification range. Gauge R+R establishes a process to measure that variation, taking into account both capability of the gauge and any variability induced by trained users.
Gemba	see **Workplace**
Goal Statement	it is a development of a **problem statement** and defines the target for a continuous improvement project. A goal statement should be succinct and use quantitative metrics without containing a predetermined solution.
Histogram	one of the **7 statistical tools**. A histogram is a graph that represents a frequency distribution using vertical blocks. The blocks are based on a class width or range of observed data, and the height of the block reflects the number of occurrences within that class width. A histogram provides visual information about the mode, range and frequency distribution pattern.

Interrelationship diagram	one of the **7 management planning tools**. An interrelationship diagram creates a visual display of how issues are related, and looks like a mind map. It is used to show cause and effect links, and allows key items to be identified. It can be a powerful tool in creating a shared understanding that can be readily communicated to outsiders. Creating an interrelationship diagram is an activity involving both logic in deducing cause and effect relationships and creativity in structuring them to make sense out of a mass of data.
Jidoka	see **autonomation**
Kanban	a Japanese term that has been imported without translation. It is a fundamental building block in the Toyota Production System and refers to a pull system of production control. The flow of material through the process is matched to the rate required by the customer. The call for work is signalled by a "kanban", typically a card that is delivered to a process stage by the next process stage requiring the product. Work is only produced when the next process stage requests it and, as a consequence, there is a dramatic reduction in work in progress with work flowing rapidly from process stage to process stage. Kanban works best where there is stable customer demand, low volume/mix variation, small batch sizes, good supplier relations and committed and trained multi-skilled persons. It requires high levels of process capability as defects and machine breakdowns quickly result in disruption throughout the supply chain, and although simple in operation needs skill in designing the number of kanban cards in a system and the batch size of those cards.
Kano Model	it was produced by Professor Noriaki Kano as a way of thinking about product design features and how they added value. He postulated three feature types – a) basic features without which the product could not sell but which added little to customer satisfaction and whose absence or poor performance would seriously detract from customer satisfaction, b) performance features that showed a roughly linear relationship between levels of performance and customer satisfaction, and c) excitement features which were generally unexpected, created a wow factor and showed huge increases in satisfaction for relatively small movements in performance. The implication are, get the basic features right at lowest possible cost and invest design effort in achieving high levels of performance features and be innovative and create excitement features which over time are eroded and become expected performance features.
KPI – Key Performance Indicator	this is the description of a metric that critically measures the performance of an attribute of a process or product/service from the perspective of the customer or key stakeholders. It specifies how we will know if a desired objective has been realised and helps to define what base data needs to be captured to make an evidence-based judgement.

Lean	the phrase was first used by John Krafcik, a researcher on the Massachusetts Institute of Technology International Vehicle Program. He noted that Japanese manufacturers were superior to their western counterparts on a whole range of criteria. They required less effort to design products, and services, less investment for a given capacity, less effort to make a given product, fewer suppliers, less Inventory and employed quicker processes. He summarised their more for less approach as " lean". Womack and Jones went on to propose an approach based on Japanese best practice which they termed "**Lean Management**"
Lean Management	developed by Womack and Jones it incorporated a number of practices into a coherent management philosophy. Their five step approach requires that first of all value is understood from the customer's perspective, then that the value stream that delivered that value is identified and analysed to eliminate waste, they then recommend that the value stream should be developed based on flow, and that the stream is optimised to react to customer pull. These four steps are mutually reinforcing, creating new opportunities, so the fifth step is about repeating these four steps to move toward perfection – a lean system that generates customer value, flowing smoothly to meet customer demand without waste. Lean management has evolved from the Toyota Production System. It has a number of distinctive characteristics however. They are a focus on the end-to-end value chain and flow, and the assumption that lean requires a paradigm change that cannot easily be accomplished without external expert help. The application of lean management is claimed to achieve radical and substantial improvements in performance.
MRP – Materials Requirement Planning	is a production planning and inventory control system used to manage manufacturing processes. An MRP system is intended to plan manufacturing activities, delivery schedules and purchasing activities; ensuring that materials are available for production and products are available for delivery to customers while maintaining the lowest possible material and product levels in store. Most MRP systems are software-based, and are often very sophisticated, with sophistication driven by the complex manufacturing systems they seek to model.
Matrix diagram	one of the **7 management planning tools**, it organises large amounts of data enabling relationships between them to be recognised . One series of items is placed horizontally, while another is placed vertically, and at the intersection point it is possible to indicate the existence of a relationship, how strong it is, and the direction of that relationship. The simplest and most common matrix diagrams (L shaped) show the relationships between two sets of variables ; T , Y and C shaped matrices can deal with 3 sets of variables with varying degrees of complexity; and X shaped matrices can deal with 4 sets of variables
Muda	see **waste**

NVA – non value adding activity	this is an activity that adds cost without contributing to any attribute desired by the customer and for which they would not be prepared to pay. NVA activities should be deleted
NNVA – necessary but non value adding activity	this is an activity that adds cost without contributing to any attribute desired by the customer and for which they would be prepared to pay, but which cannot currently be removed because it is an essential part of the process. NNVA should be reviewed so that their costs can be minimised or the process should be changed so that they cease to be necessary.
OEE – Overall Equipment Effectiveness	a key lean metric designed to support **Total Productive Maintenance**. It identifies the percentage of planned production time that is truly productive. It does this through identifying 3 factors. *Availability* takes into account down time losses for whatever reason , where the desired objective is to achieve 100% uptime and avoid all breakdowns and other causes of downtime. *Performance* takes into account any factor that causes the process to run slower than planned, where the desired objective is to operate at 100% performance and avoid slower rates of performance. *Quality* takes into account output losses due to poor quality – scrap and rework, where the desired output is 100% right first time. Performance on each factor is expressed as a % performance, and all three are multiplied together to give an overall level of effectiveness. An OEE score of 85% establishes the world-class standard, 60% is fairly typical and 40% is not uncommon for manufacturers who have yet to apply TPM. Its application within wind farm production needs creative interpretation and transposition, but is conceptually valid.
PAS 55	this is the UK asset management standard. There is an international companion standard ISO 55000.
PDPC – Process Decision Programme Chart	one of the **7 management planning tools**. It is a tool to help develop a complex implementation plan and will often precede the creation of an implementation schedule. It maps out required activities, caters for what if questions and as a consequence encourages the development of a plan that incorporates actions to resolve or mitigate potential risks. In its chart form it is essentially an objectives hierarchy or tree answering the question what do we have to achieve the higher order outcome. During plan development, 'what ifs' can be posed (almost an informal failure mode identification) and options to overcome problems can be considered and after selection entered into the chart. If charted vertically it looks just like an objectives hierarchy, if charted horizontally it looks like a function diagram – and Value Managers use function diagrams to develop implementation plans and schedules!
PDCA	see **Deming cycle**

PM – Preventive Maintenance	is an approach to maintaining an asset so that potential failures are anticipated and corrective action taken before the failures occur. Preventive maintenance can be divided into two discrete activities. Planned maintenance which is designed to extend the life of the asset through activities such as lubrication regimes or replacement of parts before the end of their theoretical life; and condition based maintenance where the asset is monitored – noise from a bearing for example, and corrective action taken as a consequence of that monitoring. It is differentiated from corrective or reactive maintenance where action is taken after failure.
Pareto Principle/Diagram	one of the **7 statistical tools**. Pareto diagrams display the cause of problems in bar chart format in diminishing order of frequency. This graphical presentation makes the importance of causes readily discernible. The Pareto principle, also known as the 80/20 rule states that 80% of the effects come from 20% of the causes, and graphically this would be represented by the Pareto distribution. The importance of the Pareto principle, named after an Italian economist, is that by focusing your efforts on the few most significant causes you can have a disproportionately large impact on the results. The key therefore is to identify the important 20% of causes that will leverage improvement efforts.
Poka-yoke	see **fool-proofing**
Problem Statements	a brief description of a problem that explains the impact of the problem on the customer and organisation using objective measures and defining the scope of the problem.
Process maps	also known as 'process flowcharts', these are one of the most useful and widely used tools in CI and in process re-engineering generally. They are a means of diagrammatically capturing and communicating how a process does or could work. They have many applications and can take many forms, with some methods using a few, simple symbols and others a wider and more sophisticated set of symbols.
Project Structure	a project structure describes the key project roles and responsibilities and how they relate to each other. A project structure can be further clarified using a **RACI chart**.

Quality	a term that is used inconsistently and risks being all things to all men. The common usage of quality as purity of contents, care in presentation and finish of a product is not one generally used when considering quality from a business improvement perspective. In the 1970s, Philip Crosby defined quality simply as conformance to specification, and introduced the concept of the **cost of poor quality (COPQ).** He showed that the **COPQ** was often in excess of 15% of operating costs, thereby demonstrating that quality was effectively free and organisations did not have to trade off quality and cost. As it was realised that conformance to specification was only of value if the specification reflected customer needs and wants, quality was redefined as meeting or exceeding customer expectations. Later as it was recognised that meeting customer needs was unsustainable if costs did not enable profit generation, quality was therefore redefined as meeting or exceeding customer expectations at a cost that enabled a sustainable organisation. It is not always clear which of these specific or general definitions is being used, and they can and do create inconsistencies. From one perspective (meeting customer needs) it has been shown that Skoda can have greater quality (higher customer satisfaction ratings) than Mercedes: While a definition that focused on care in presentation and product finish would result in reversing the relationship.
QA – quality assurance	defined in ISO 9000, which is the standard for QA, as "All those planned and systematic activities implemented to provide adequate confidence that an entity will fulfil requirements for quality." QA is process oriented and focuses on defect prevention. It seeks prevention of quality problems through planned and systematic activities to ensure that the processes by which products are developed and produced are capable and fit for purpose. QA is therefore a proactive quality process and the goal of QA is to improve product and process development and test processes so that defects do not arise when the product is being developed and produced. **APQP** is closely allied with QA, both being concerned with designing capability in.
QC – quality control	defined in ISO 9000 as "The operational techniques and activities that are used to fulfil requirements for quality**".** QC is product oriented and is a set of activities that focus on identification and correction of defects. It is a reactive process, and is sometimes identified as a sub set of QA.
QC – quality circles	small groups that voluntarily undertake improvement activities in the work place. They originated in Japan where they were a key element in Kaizen application. Supported by management, they were trained to use the **7 statistical tools** and the **PDCA** improvement cycle. Attempts to establish them in western manufacturing frequently foundered, as the broader context within which they existed was neither understood nor replicated.

RACI chart	*Responsible, Accountable, Consulted and Informed* – a chart that seeks to identify various role categories within a project. A person with an accountability role has to ensure that a desired activity takes place and is effective, but does not lead the activity – he or she will be held accountable for inadequate performance. A person with a responsibility role leads the activity, makes things happen and reports to a person with an accountability role. In performing the responsibility role, a number of stakeholders will need to be consulted and their views taken into account in any decision, while others may simply need to be informed after the event.
Root Cause Analysis	is a process that seeks to move from superficial causes or symptoms of a problem to reveal the fundamental causes that if addressed will not simply alleviate symptoms but resolve the problem. It does this by taking the initial level of causality and decomposing them into secondary level causes by asking "why do the primary causes exist?". This process of decomposition is continued until a level of causality is reached which if addressed will resolve the problem. A degree of judgement is required to determine when to stop analysing and start resolving a problem. The 5 Whys approach to root cause analysis suggests that decomposition of the problem should not be continued beyond the fifth level, and may stop sooner.
RPN – Risk Process Number	see **FMEA**
SCAMPER	an acronym for seven different perspectives that can be used to generate ideas. Those perspectives are opportunities for *Substitution*, *Combination*, *Adaptation*, *Modification*, *Putting to another use*, *Elimination* and *Reversion*. It is a structured approach to idea generation that can reinforce the free-thinking approach of **Brainstorming**.
Scatter Diagram	one of the **7 statistical tools**. These are simply plots of data on a two-axis graph that enable you to see how movement in values on one axis impact on values on the other axis. Lines of best fit can be superimposed- either estimated by eye or calculated, and creates a simply understood way of expressing correlation between two variables.
Sigma (σ)	see **standard deviation.**
Six Sigma	is both a statistical concept and a management approach. As a statistical concept, it measures a process in terms of how capable it is by reference to defect rates. A six sigma process will only deliver 3.4 defects per million outcomes – the process is highly capable and almost perfect. As a management approach it defines the thinking, methods, tools and structures needed to realise very highly capable processes.
SIPOC – Supplier, Input, Process, Output and Customer	this is an acronym to capture key elements in a high-level process map. The logic is that a supplier(not necessarily external) creates an input that is received by a process and perhaps combined with other inputs to create an output that seeks to meet the customers' needs.

SMART	has two meanings. It is most commonly used to describe objectives so that they are **S**pecific, **M**easurable, **A**chievable, **R**elevant and **T**ime bound. An alternative use of the acronym is to describe a technique to determine the relative importance of variables in any situation. It then refers to **S**imple **M**ultiple **A**ttribute **R**ating **T**echnique.
SMED – Single minutes exchange of dies	is a system for dramatically reducing the time it takes to complete equipment changeovers. Although developed in manufacturing, it can be used in a wide range of activities – changing over from one operation use to another in an operating theatre. The best-known example of using SMED is the approach used to change wheels in Formula 1. The essence of the SMED system is to convert as many changeover steps as possible to "external" (performed while the equipment is running), and to simplify and streamline the remaining steps. The term Single-Minutes Exchange of Dies comes from the goal of reducing changeover times to the "single" digits (i.e. less than 10 minutes) – reductions of 90% in changeover times are not uncommon. A successful SMED programme will reduce operating costs, enable smaller batch sizes, lower inventory, respond to the customer faster and create smoother start-ups.
SPC – Statistical Process Control	is an approach that uses statistics, normally control charts, to control process outputs. Control limits based on the natural or common cause variation of the process are established, and time data is plotted on the control chart. Rules are used to interpret the plotted results and to anticipate problems and take corrective action before defects occur. A process may be in statistical control but not be capable. The establishment of control limits and their comparison with specification limits, allows capability to be assessed and the need to improve process capability identified. An important part of SPC focuses not simply on controlling the process but seeking to improve it, so that variation in performance is continually reduced. While control will normally be undertaken by the process operator, improvement may involve specialists using techniques such as **design of experiments** to identify and control key process inputs. The application of SPC can have a dramatic positive effect on process capability, and it is essential that thorough training is undertaken before SPC is applied. Note many authors do not differentiate between SPC and **SQC** and use SPC to include activities that others might assign to **SQC**.

SQC – Statistical quality control	is the application of statistics to control and improve performance. Some authors differentiate **SPC** and SQC by recognising that they use the same tools but that SPC is applied to process inputs while SQC is applied to process outputs/product characteristics. Others include **SPC** within SQC, while others use **SPC** to cover both process inputs and process outputs/product characteristics**.** The distinction between SPC and SQC is therefore often unclear as it is common practice to measure variation in process outputs/product characteristics and infer from that changes in process inputs. Changes in surface finish for example being attributed to deterioration in tool geometry and/or supply of lubricant. Most people would recognise that as **SPC** while others would argue that it was SQC!
Standard deviation or sigma (σ)	is a statistical term to describe the degree of variation in a set of data or a process from its mean or average. The higher the standard deviation, the greater the variation and therefore the more likely that output values will lie outside desired limits. The statistical formula is $\sigma = \sqrt{\sum(x - \bar{x})/n}$, where √ is the square root, ∑ is the sum of, x is an observed value, $\bar{x}$ is the arithmetic mean or average and n is the number of observations. In a normal distribution where events are spread symmetrically around the mean ± 1 σ will encompass 68 % of the distribution, ±2σ will encompass 95%, and ±3σ will cover 99% of the distribution. Understanding standard deviation is important in developing statistical process control – but not essential in applying it.
Suggestions schemes	schemes designed to encourage employees to make improvements to the processes and products in which they are engaged. Proposals are submitted, formally evaluated and suggestors are advised of the evaluation. A key element of suggestions schemes is that participants are acknowledged, valued and rewarded – reward often but not necessarily includes a financial element. Experience from Japan indicates that Suggestion Schemes need to go through three phases. In the first phase, the focus is on helping employees improve their work place and processes; the second phase focuses on education so that people can develop improved ideas independently; it is only in the third phase after the work force is committed and educated that the focus can switch to the economic impact of the suggestions. Suggestion rates vary enormously, Masaaki Imai quotes an average rate of around 20 suggestions per employee per year in his book “Kaizen”.

Synectics	is a generic label for a range of techniques, behaviours and meeting structures that have been identified as increasing g the probability of success in invention and creative problem solving. It uses techniques to encourage creativity, involving metaphor, analogy, fantasy, visualisation, association, absurdity/force fit. These "excursion" techniques provide distance from the problem and are intended to open up novel avenues of approach. They need to be selected with care, as some techniques may not be culturally acceptable to some groups. Synectics is more demanding of the subject than brainstorming, as the many steps involved mean that the process is more complicated and requires more time, effort and skill in application.
TOC - Theory of Constraints	developed by Eli Goldratt, it is based on the idea that all processes contain an activity that constrains all the others – the bottleneck, and that the focus for improvement should be on progressively identifying and improving bottleneck activities - a chain is no stronger than its weakest link. Unlike **Lean management,** which seeks to remove waste throughout the value stream, TOC argues that improvements in a non-bottleneck activity are largely illusory. Real benefits will only be realised by progressively removing bottlenecks until the system throughput capacity is balanced. Although developed initially to deal with manufacturing scheduling problems, TOC has been broadened to address any process optimisation issue, so that a constraint is anything that stops a system achieving its goal(s). An important development of this has been a unique problem solving process – The Thinking Process.
The Thinking Process	part of Eli Goldratt's **Theory of constraints**, the Thinking Process is a structured problem solving approach. In structure, it is similar to many improvement processes. It is unique in specifically seeking to identify conflicts that make problem resolution difficult and then focusing on ways to resolve those conflicts through the use of a conflict resolution or evaporating cloud diagram. The main steps are to create the current reality tree (an 'as is' process map) which captures undesirable effects and pinpoints root causes. The conflict resolution diagram is then used to develop solutions that resolve the conflicts that sustain the problem, and these are then incorporated in a future reality tree (a 'future state' map). Negative Branch Reservations are then developed to explore possible negative ramifications of proposed actions and modify them accordingly. The prerequisite tree identifies all the sub objectives that need to be realised and obstacles to be overcome. This is then translated into the Transition Tree, which identifies all actions needed to implement the desired future state. There is some similarity here with the **PDPC** chart, which has the same function.
TPM – Total productive maintenance	is a holistic approach to equipment maintenance that seeks to avoid breakdowns, slow running and the production of defects. It is based on operators maintaining their own equipment and emphasizes team-based proactive and preventive maintenance.

TQM – Total Quality Management	consists of organisation-wide efforts to install and make permanent a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers. It is helpful to see TQM as part of an evolutionary process, as a stage of quality management development. The first three stages are inspection, quality control, and quality assurance. TQM incorporates all previous stages and incorporates a number of additional features. They are a greater emphasis on the customer, working with suppliers to involve more of the value stream, developing people so that their contribution is encouraged and leveraged, and working with facts to develop evidence based decisions. In addition to continuous improvement, some argue that TQM also includes thinking radically about customers, products and processes.
Tree diagram	one of the **7 management planning tools** – it displays in linear logic how high level objectives are decomposed into lower level objectives and ultimately into implementation actions. It is a very useful tool as it not only creates a clear structure but also allows for the relative importance of different objectives at the same level to be compared. Objectives hierarchy, value tree, function diagrams , CTQ trees and fault tree are all tree diagrams used in a specific situation by different management disciplines, often with customised charting conventions.
TRIZ	is a creative problem solving methodology developed by Genrich Altshuller, a Russian inventor and patents expert. The system is based on a belief that problems can be categorized into types and that solutions transcend traditional operational boundaries, so that solutions applied in one domain are useful in quite different domains. A very extensive database of problem solutions can be searched using tools that have first been applied to categorize the problem.
VOC - Voice of the Customer	a generic term to cover a range of activities that seek to understand and, if necessary, structure what customers need and want. A key element is to be clear about who the customer is, and what they want. Complex situations can exist with multiple customers with different and perhaps conflicting needs. Activities will cover focus groups, review of customer complaints, and surveys to understand wants and needs but may need to be structured into different segments to respond effectively to those needs.
Value	this is a term open to multiple interpretations. Within Value Management, value is defined as a judgement about the relationship between benefits derived from a product (used in its widest sense to cover outputs from a process) and the resources expended to realise those benefits. Value can be improved by maintaining benefits and reducing resources expended, increasing benefits while maintaining resources expended, reducing benefits less than resources expended or increasing benefits greater than resources expended.

Value Profile	this is very similar to a value proposition, and defines a product or service in terms of the objectives and the levels of performance that must be achieved to meet the high-level requirements of key stakeholders. It critically makes the trade-off between objectives explicit, and thus creates an envelope within which designers can work, understanding how movements in anticipated performance, will add to key stakeholder value. It can be presented as a graphed profile or star chart. It is an important stage in determining the relative value and value for money of competing options.
Value Stream	the value stream describes all the organisations and activities required to produce a product or service**.** The phrase value chain was popularised by Michael Porter, and is generally taken to cover activities within an organisation, while the value stream includes every activity from raw materials sourcing to finished product or service delivered to the customer.
Value Stream Mapping	an approach developed to support a key element of **lean management**. Value stream mapping is a variant of process mapping that seeks to capture activity in the entire value stream with a focus on those metrics related to flow and uses different charting conventions. "Learning to See" was one of the first guides to value stream mapping, it encourages hand drawing with simple intuitive icons and metrics such as number of product variations, cycle time, change over time, machine uptime, production batch sizes, number of operators, pack size, working time and scrap and rework rates. Value stream maps should capture both current and future state maps.
Visible Management	one of the building blocks of kaizen and all associated process improvement methodologies is the need to use visible management to make issues accessible and encourage involvement. Visible management can take various forms, but the key is that it is local, accessible, and readily understandable and encourages involvement in improvement activities.

Waste	or **muda** in Japanese, is a fundamental concept in all process improvement methodologies. Unlike quality, performance or value, it is a term that is readily understood and everyone can readily agree that waste is undesirable. Within the Toyota Production System, 7 categories of waste were identified. They were (1) overproduction (believed by Taiichi Ohno, Toyota's Chief Engineer to be the most insidious), (2) waiting time,(3) transport – excessive movement, (4) over processing, (5)unnecessary inventory, (6) unnecessary motion, and (7) defects. Additional process waste categories have been added including wasted human potential, and with increasing environmental awareness waste of energy and pollution. While these definitions of waste are incredibly important from the perspective of aligning effort to improve process operation and design, the area of waste in product design is largely overlooked, and this is often of more significance than process waste though less readily amenable to change. Value Management is one of the few management methodologies that specifically seek to address this area of waste and value loss.
Workplace	or 'gemba' in its original Japanese. In CI there is a strong emphasis on observing actual activity at the workplace. "Go to the gemba (workplace)" is a significant saying in Kaizen; the importance of visiting the workplace is to see things as they really happen, warts and all, rather than receive a sanitised version that may hide problems and opportunities.