VALUE ANALYSIS
VALUE ENGINEERING

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INNOREGIO: dissemination of innovation and knowledge management techniques

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Contents

1 WHAT IS VALUE ANALYSIS

This report provides a management overview of a 'process' known as Value Analysis. Value Analysis (VA) is considered to be a process, as opposed to a simple technique, because it is both an organized approach to improving the profitability of product applications and it utilizes many different techniques in order to achieve this objective. The techniques that support VA activities include 'common' techniques used for all value analysis exercises and some that are appropriate under certain conditions (appropriate for the product under consideration), see also chapter 3.2 . The VA approach is almost universal and can be used to analyze existing products or services offered by manufacturing companies and service providers alike. For new products, the Value Engineering (VE) approach, which applies the same principles and many of the VA techniques to pre-manufacturing stages such as concept development, design and prototyping.

At the very heart of the VA process review is a concern to identify and eliminate product and service features that add no true value to the customer or the product but incur cost to the process of manufacturing or provision of the service. As such, the VA process is used to offer a higher performing product or service to the customer at a minimal cost as opposed to substituting an existing product with an inferior solution. This basic principle, of offering value at the lowest optimal cost of production, is never compromised. It is the principle that guides all actions within the VA process and allows any improvement ideas to be translated into commercial gains for the company and its customers. The VA process is therefore one of the key features of a business that understands and seeks to achieve Total Quality Management (TQM) in all that it does to satisfy customers. For many of the worlds leading companies, including names like Hewlett Packard, Sony, Panasonic, Toyota, Nissan, and Ford, the VA process of design review has provided major business returns. The key to realizing these returns is knowledge, of the customer requirements, the costs of the product, and an in-depth knowledge of manufacturing process and the costs associated with failures due to poor or inadequate product design. All these inputs to the VA process are vital if decisions regarding product and process re-design are to yield lower costs and enhanced customer value.

The Value Analysis technique was developed after the Second World War in America at General Electric during the late 1940s. Since this time the basic VA approach has evolved and been supplemented with new techniques that have become available and have been integrated with the formal VA process. Today, VA is enjoying a renewed popularity as competitive pressures are forcing companies to re-examine their product ranges in an attempt to offer higher levels of customization without incurring high cost penalties. In parallel, many major corporations are using the VA process with their suppliers to extend the benefits of the approach throughout the supply chain. Businesses, big and small, will therefore benefit from understanding and applying the VA process. It is likely that those companies that do not take the time to develop this capability will face an uncertain future as the lessons and problems of the past are redesigned into the products of the future.

1.1 Definition of Value Analysis

Value Analysis can be defined as a process of systematic review that is applied to existing product designs in order to compare the function of the product required by a customer to

meet their requirements at the lowest cost consistent with the specified performance and reliability needed.
This is a rather complicated definition and it is worth reducing the definition to key points and elements:

1. Value Analysis (and Value Engineering) is a **systematic, formal and organized process of analysis and evaluation**. It is not haphazard or informal and it is a management activity that requires planning, control and co-ordination.
2. The analysis concerns the **function of a product** to meet the demands or application needed by a customer. To meet this functional requirement the review process must include an understanding of the purpose to which the product is used.
3. Understanding the **use of a product** implies that specifications can be established to assess the level of fit between the product and the value derived by the customer or consumer.
4. To succeed, the **formal management process must meet these functional specification** and performance criteria consistently in order to give value to the customer.
5. In order to yield a benefit to the company, the formal review process must result in a **process of design improvements** that serve to lower the production costs of that product whilst maintaining this level of value through function.

1.2 Defining Cost and Value

Any attempt to improve the value of a product must consider two elements, the first concerns the use of the product (known as **Use value**) and the second source of value comes from ownership (**Esteem value**). This can be shown as the difference between a luxury car and a basic small car that each has the same engine. From a use point of view both cars conduct the same function – they both offer safe economical travel (**Use value**) – but the luxury car has a greater **esteem value**. The difference between a gold-plated ball pen and a disposable pen is another example. However, use value and the price paid for a product are rarely the same, the difference is actually the esteem value, so even though the disposable pen is priced at X the use value may be far less.

It is important for all managers to understand the nature of costs in the factory and for any given product. Whilst there is no direct relationship between 'Cost' (for the factory) and customer 'Value' in use and esteem, this education process is important. A shocking figure, that is often used as a general measure, is that typically 80% of the manufacturing costs of a product will be determined once the design drawing has been released for manufacturing. The costs of production are therefore 'frozen' and determined at this point. These costs include the materials used, the technology employed, the time required to manufacture the product and such like. Therefore, the design process creates many constraints for the business and fixes a high degree of the total product cost. It is therefore a process that demands periodic review in order to recover any 'avoidable' costs that can be removed throughout the life of the product (by correcting weaknesses or exploiting new processes, materials or methods) and lowering the costs of production whilst maintaining its Use value to the customer.

Basically, there are three key costs of a product:

- **Cost of the parts purchased**: These are costs associated with the supply of parts and materials.
- **Cost of direct labour** used to convert products.

- **Cost of factory overheads** that recover the expenses of production.

Although there are three elements of total cost accumulation it is traditionally the case that cost reduction activities have focused on the labour element of a product. Activities such as work-study, incentive payments and automation have compressed labour costs and as a result there is little to be gained, for most companies, in attempting to reduce this further. Instead, comparatively greater gains and opportunities lie in the redesign and review of the products themselves to remove unnecessary materials and overhead costs. This approach to the 'total costs' of a product involves taking a much broader look at the way costs in the factory accumulate and the relationship between costs and value generation. These new sources of costs and evaluations would therefore include such sources as:

- **Cost of manufacture**
- **Cost of assembly**
- **Cost of poor quality**
- **Cost of warranty**

A detailed understanding of how costs are rapidly accumulated throughout the process of design to the despatch of the product is key to exploiting the process of VA. All VA activities are aimed at the reduction of avoidable and unnecessary costs, without compromising customer value, and therefore the VA process should target the largest sources of potential cost reduction rather being and indiscriminate or unsystematic process (such as focusing on labour alone). It is therefore preferable to take the holistic approach to understanding costs and losses in the 'entire system' of design and conversion of value in order to determine how to achieve customer service 'functionality' at a minimal cost per unit.

1.3 The Focus of Value Analysis

The key focus of the VA approach is therefore the management of 'functionality' to yield value for the customer. Let us emphasize this point a little. Not that long ago, consumers of electric kettles were offered a variety of different types of metal-based boiling device. The value of a kettle is derived through heating water and therefore its functionality can be determined (temperature, capacity, reliability, safety etc.). Now faced with the same functionality (to boil water), designers would probably look towards a kettle made of plastic. Plastic has the same functionality as metal in terms of containing and boiling water. The action to boil water is conducted by the same part - known as the element. However the switch from metal to plastic does not impair this value and functionality with the customer – they still want to boil water - but it does result in a cost saving for the manufacturing company. If a company that traditionally made metal kettles did not review its design process then it would be severely disadvantaged when attempting to compete against the lower cost plastic alternative. This is a simple example used only to provide an illustration of the VA concept but it does demonstrate the point of maintaining value whilst reducing costs.

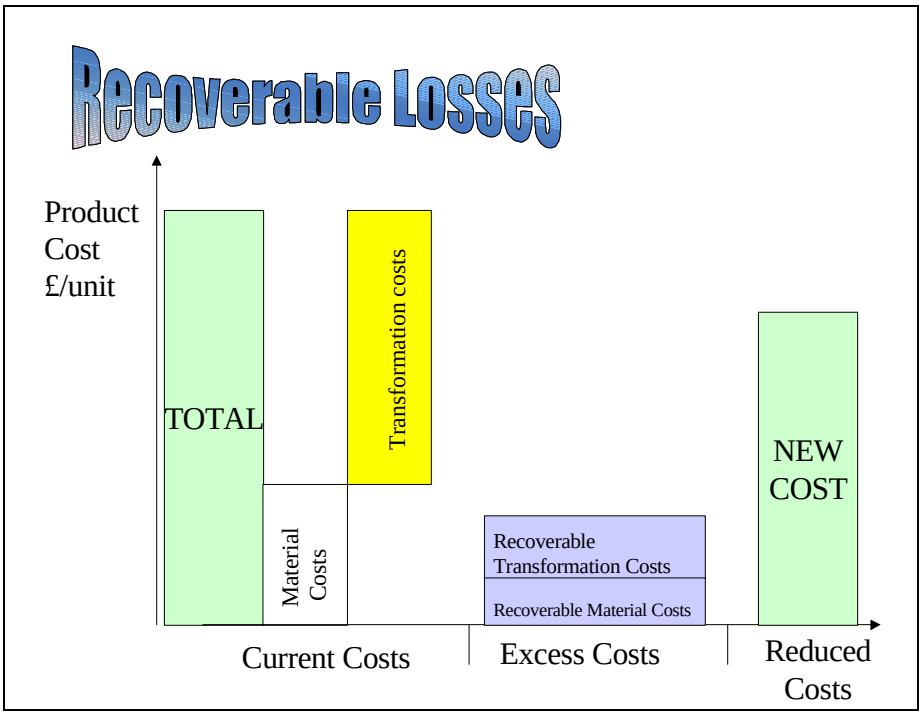
If a company seeks to reduce the costs of producing a product then it must seek out costs that are unnecessary or items of the product that provide no functional value to the customer. If you adopt this approach then the VA process is concerned with removing a specific type of cost. This cost is one that can be removed without negatively affecting the function, quality, reliability, maintainability or benefit required by the customer. As such, the target for all VA activities is to find these costs as opposed to simply re-engineering a product design with no

real purpose to the re-engineering exercise. The VA approach is therefore formal and systematic because it is directed towards highlighting and dealing with these 'recoverable costs' of production. The objective is to create value for money as opposed to creating new products that do not provide customer satisfaction but are relatively inexpensive.

The rules governing the application of the VA approach are therefore simple:

- **No cost can be removed if it compromises the quality of the product or its reliability**, as this would lower customer value, create complaints and inevitably lead to the withdrawal of the product or lost sales.
- **Saleability is another issue that cannot be compromised**, as this is an aspect of the product that makes it attractive to the market and gives it appeal value.
- **Any activity that reduces the maintainability of the product increases the cost of ownership** to the customer and can lower the value attached to the product.

In essence, the following diagram shows the process of VA and the development of knowledge about the costs of a product in such a way that the costs are gradually decomposed to a high level of detail. At this point, the recoverable losses associated with the current design can be assessed and targeted for reduction to yield, as a result, the same value but at a reduced cost base. In the example, the current costs are decomposed into those related to materials and those related to conversion before analyzing, in greater detail, the materials costs and the opportunities to recover costs through redesign and the opportunities to recover transformation or conversion costs.



1.4 Why Use Value Analysis

In reality, a complex number of reasons exists that necessitate the structured approach of value analysis as a means of logical cost reduction. These reasons can be divided into two key sources, those that lie within the business and secondly those that are stimulated by the market for the product or service.

1.4.1 Within the business

Design related issues

The major reasons why VA exercises are conducted actually originate from the design process itself and the lack of control systems concerning reviews of product performance once the product has entered the production stage. Some of the problems associated with a lack of proper design review systems are listed below:

- The designer may not be aware of **'best practice'** with which to develop an optimal design. The designer may also be unaware of the cost implications of one design over another due to insufficient information or a poor understanding of new materials and technologies that could be used to make the product. Therefore the review process allows the opportunity to incorporate these new sources of cost reduction. The process also offers vital information feedback to the designer regarding the performance of the design in production.
- The designer may have produced a drawing that was intended for **technology that has been replaced** by the company since the product went into full production. The VA process also allows these changes to be incorporated formally.
- **Traditional thinking and customary practice** may have led the designer to believe that a particular solution was the best without questioning the line of logic. Instead, the belief that a traditional and proven solution will be adequate for a modern consumer can create products that do not entirely provide the value sought by the customer. The review forces the designer and other professional managers to assess the 'fit' between what the customer 'wants' and the solution provided by the company.
- The designer, **under time pressure to create designs for immediate production and sale**, may be forced to cut corners and pay insufficient attention to the design itself due to the pressure to release a design for production. Therefore insufficient or inadequate analyses may have been undertaken during the planning of the product characteristics and the relative costs of different designs. Therefore the pressure to sell a physical product, and collapse the time from the drawing board to the salesman, can mean that designers are forced to compromise the quality of the design in order to simply meet the commercial pressure to release products to the market. The VA process forces a review of these designs and allows the weaknesses in existing products to be addressed through periodic reviews. It is therefore a routine that allows corrective actions to be taken.

Obviously, these problems conspire against the designer, cause frustration for designers and also become sources of discontent for other employees in a business. These frustrations caused by poor design activities, impact on the engineers in the factory who have to try and manufacture the product in a less than optimal way. Production operators also face the problem of continually adjusting the product to meet quality standards and in so doing slow the rate of production and output. Therefore any small error that deviates from the optimal design will create costs in the factory. It is these costs that can be recovered, reduced and

managed through the formal process of VA. The VA process is also a means of learning from past mistakes and constantly refining the ability to create 'right first time' designs in less time for the business which is a source of competitive advantage.

If a product was designed optimally and 'right first time', which is actually against the law of probability, then **the product would offer the most value in providing the function sought by the customer in the most reliable way and lowest cost.** The Value Analysis approach is therefore the means of maintaining the value proposition for the customer through periodic reviews that serve to continuously improve the process of 'design to marketplace'. It is therefore a key strategic capability for any business that seeks to differentiate its products from the competition. At the very least, the VA process allows a company to correct design weaknesses after the product has entered production and therefore to cease paying for activities that add no value for the customer offer but costs which tend to be passed on to the customer. In essence, VA is used to maintain the fit between the product, low costs, and high-perceived customer value.

Further 'internal' reasons for conducting VA exercises include:

- **Products with known problems** that from the pilot production stage continue to be produced but require remedial, corrective actions, and engineering change requests.
- **Customer Demands**. Most markets require suppliers to offer a range of products and to continuously increase this offering. To avoid an explosion in the number of unique parts associated each new product many companies have introduced standard components, platform strategies and supplier rationalization programmes. The ability to design products is seen as key to maintaining the quality, cost and delivery performance of the product. Some customers, especially those in mature markets, need to continuously reduce the costs of products in order to compete against comparatively cheaper imports. The increasing trend, across Europe, for businesses to 'buy in' rather than 'make' all the elements of a product means that new suppliers of materials must be educated in the VA process in order to use the specialist skills of the supplier to reduce the costs of supplied materials continuously.
- **Safety and Compliance Requirements** for products in the market or being sold within markets that have different safety legislation implies that VA activities must be used to review the compliance of a product with the prevailing legislation and changes to that legislation.
- **The Improvement of Product Margins**. VA is often used to combat the perpetual and expected price reductions between a supplier and a customer. Therefore as a protective measure many businesses employ VA to reduce costs and to protect their own profit margins.
- **Corrective Action**. To redress known problems with existing product designs or to reduce the costs associated with failure (including warranty, complaints and poor quality within the factory and with the customer).

In conditions where the market determines the price, any attempt to reduce costs or recover losses through redesign and improvement activities will provide a major return to the business throughout the life of the product. This total lifecycle saving can amount to a large financial saving.

1.4.2 Market induced Reasons

There are many modern competitive trends and pressures that make the VA approach a valuable activity within any business. These pressures include:

- **Pricing Practice**. The traditional approach to setting the price of a product has been to determine the costs of the product and then to add a 'margin' to provide the profit (known as 'cost plus' pricing). However in the modern competitive environment, the market tends to determine the acceptable price that can be commanded for a product. As such, companies with high costs and a relatively fixed market price will command less profit if costs are not managed properly and reduced continuously. The VA process accommodates this need to manage and continuously seek ways of reducing product costs.
- **The Advent of E-Commerce**. The new information technology available to customers means that product purchasing is now a global exercise. Therefore in order to maintain a relationship with an existing customer and to protect this relationship, enhancing the value and lowering the costs of existing products will be vital to competitiveness.
- **Reducing Complexity**. The general trend in European industry is to rationalize the number of suppliers to a business and to reduce the vast number of parts that were traditionally bought and stocked. Therefore, the ability to redesign products to incorporate common parts will lead to financial savings in space and the costs of inventory.
- **Compliance with Quality Regulations**. Most of the quality management systems, such as ISO9000 series, require companies to operate a formal design review process to ensure that the quality of the product can be assured. This is an element of the quality accreditation system that is monitored and audited by external agencies. As such, companies that fail to comply with these procedures will fail to qualify for the quality award and can lose business as a result.
- **New Technology and Materials**. The discovery and invention of new processes and materials means that this form of innovation can be incorporated within existing product designs such that the reliability and quality of the product can be improved whilst simultaneously reducing costs. This market intelligence and the ability to take advantage of innovation for product designs are vital to improving the performance of the product and the factory.
- **Environmentalism**. The growing awareness of environmental issues is reshaping the buying behaviour of customers and consumers in Europe. It is effectively redefining the esteem value of a product and can, through legislation, affect what materials can be used in the production of products and therefore environmental pressures serve to redefine the 'use' value through changes in product specifications (for example CFC gases in refrigerators and aerosols). In addition many companies, notably vehicle producers, have begun to direct attention towards reducing the weight (and material content) of purchased parts to meet environmental and efficiency targets for themselves.

1.5 Types Of Value Analysis Exercises

VA for Existing Products

One of the best approaches to VA is simply to select an existing product that is sold in relatively large volumes. This product, or product family, will tend to have a great deal of the

basic information, and documented history, which can be used quickly as opposed to a newly introduced product where such a history is not available. An existing product unites all the different managers in a business, each with an opinion and list of complaints concerning the ability to convert the design into a 'saleable' product. Therefore any team that is created for the purpose of VA will understand their own problems but not necessarily the cause of these problems across the entire business. These opinions regarding poor performance (and documented evidence of failures) are vital to the discussions and understanding of how the product attracts costs as it is converted from a drawing to a finished product. These discussions therefore allow learning to take place and allow all managers to understand the limitations to the scope of product redesign and re-engineering activities. These issues include:

- The inability to change existing product designs due to the need to redesign tooling and the expense of such an initiative.
- The project team may have a finite duration before the project is concluded and therefore time will dictate what can be achieved.
- The high levels of purchased costs may imply a need to engage with suppliers in the VA process. This initiative will be constrained by a number of issues such as the timing of the project, the availability of resources from the supplier, the location of the suppliers, and other constraints.

VA for New Products – Value Engineering

For new products, the team will need to modify the VA approach and will operate in an environment that is less certain and has poor levels of available information upon which to make decisions. In this case, the analysis and systematic process of review for new products is known as Value Engineering (VE). The VE approach is similar to that of Value Analysis but requires a much greater level of investment by the organization in terms of the skilled, experienced and proficient human resources seconded to the group. For more detailed information on Value Engineering as opposed to Value Analysis please refer to the references listed at the end of this report.

VA for Product Families- Horizontal Deployment

The final form of VA is results when there is scope for the 'horizontal deployment' of the results of a VA exercise with a single product or family of products. Under conditions where the value analysis project team finds commonalties with many products manufactured by the company, then it is possible to extend the benefits to all these other products concurrently. In this manner, all affected products can be changed quickly to bring major commercial benefits and to introduce the improvement on a 'factory-wide basis'. This is particularly the case when supplying companies offer improvements that affect all the products to which their materials or parts are used. The horizontal deployment activity has many advantages both in terms of financial savings and also the relatively short amount of time required to introduce the required changes to the product design.

Competitive VA

VA techniques are not simply the prerogative of the business that designed the product. Instead VA is often used as a competitive weapon and applied to the analysis of competitor products in order to calculate the costs of other company's products. This is often termed 'strip down' but is effectively the reverse value analysis. Here the VA team are applied to understanding the design and conversion costs of a competitor product. The results of the

analysis is to understand how competitor products are made, what weaknesses exist, and at what costs of production together with an understanding of what innovations have been incorporated by the competitor company.

It is recommended that the best initial approach, for companies with no real experience of VA, is to select a single product that is currently in production and has a long life ahead. This approach offers the ability to gain experience, to learn as a team, and to test the tools and techniques with a product that has known characteristics and failings. In the short term it is most important to develop the skills of VA, including understanding the right questions to ask, and finally to develop a skeleton but formal process for all VA groups to follow and refine.

2 HOW TO USE VALUE ANALYSIS

2.1 Keys to Success

There are many keys to the success of a VA programme and it is wise to consider these issues before commencing the project, as errors in the project plan are difficult to correct, without causing frustration, once the VA project has started. One of the most important initial steps in developing the VA process is to create a formal team of individuals to conduct the exercise. These individuals must be drawn from different parts of the business that affect the costs associated with design, manufacturing, supply and other relevant functions. In addition, the team must be focused on a product or product family in order to begin the exercise. Further key success factors include:

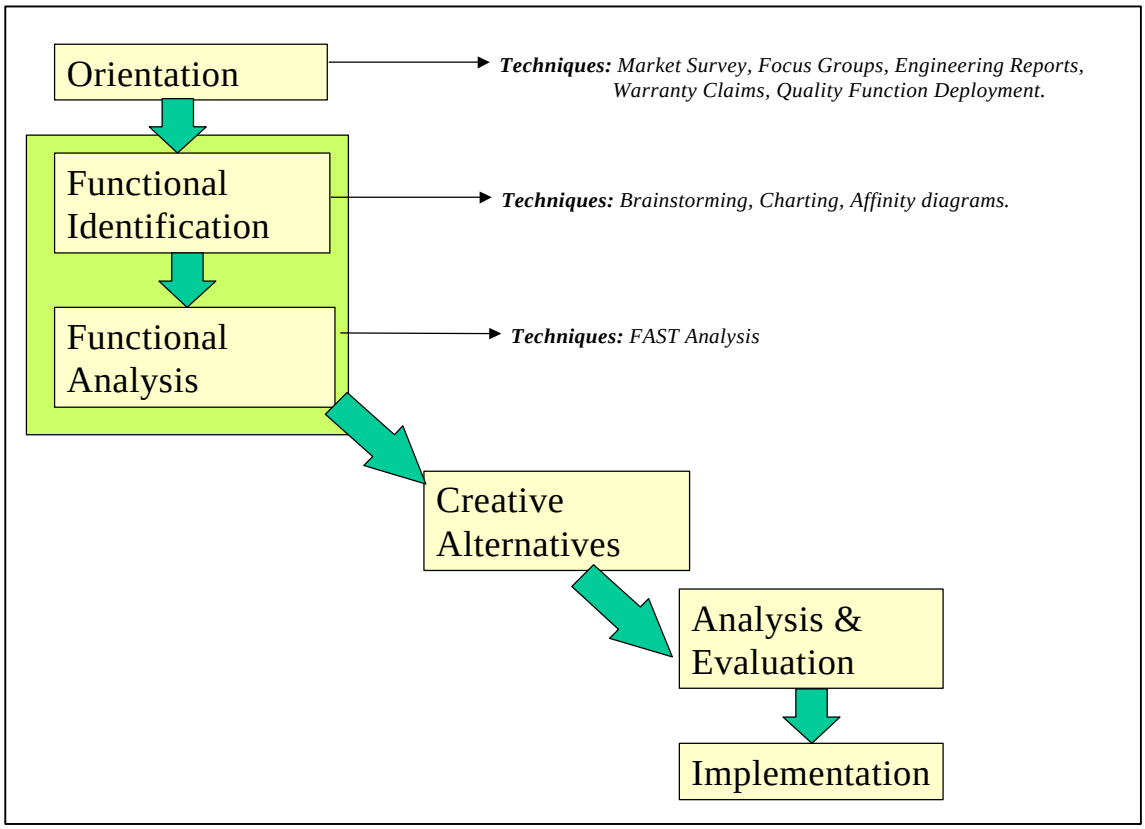
- **Gain approval of senior management** to conduct a Value Analysis exercise. Senior management support, endorsement and mandate for the VA project provides legitimacy and importance to the project within the business. This approval process also removes many of the obstacles that can prevent progress from being made by the team.
- **Enlist a senior manager as a champion** of the project to report back directly to the board of directors and also to act as the programme leader.
- Once a programme team has been developed it is important to **select an operational leader** to co-ordinate the efforts, monitor progress and to support the project champion. This leader will remain with the VA team throughout the life of the project and will be the central linking pin between the team and the senior management champion.
- **Establish the reporting procedure** for the team and the timing of the project. This project plan needs to be formal and displayed as a means of controlling and evaluating achievements against time.
- **Present the VA concept and objectives of the team to all the middle and senior managers** in the business. Widespread communication of the VA project is important so that other employees, particularly managers (who may not be involved directly with the process) understand the need to support the project either directly by assigning staff or indirectly through the provision of data.
- Maintain a list of those business functions that should receive a **regular communication of progress** even though they may not be directly involved with the project. This process allows other individuals in the business to be informed about the progress and findings of

the group. This form of promotion is important as it maintains a momentum and communicates the findings of the team as widely as possible.

- **Provide an office space and co-locate the team members** where practical and possible to do so. The ability to locate a VA improvement group in one area of the business is important and assists the communication within the group. A convenient area can also be used to dismantle the product and also the walls of the area can be used to record, on paper charts, the issues that have been discovered by the team (and the associated actions that must be undertaken).
- **Select the product** for the first study. Ideally the existing product, or family of products, will be one that is established, sells in volume and has a relatively long life expectancy. As such any improvement in the cost performance of the product will provide a large financial saving to the business (see chapter 2.2.3 for detail).
- Write down the **objectives of the project** and the key project review points. Estimate the targets to be achieved by the project. These objectives provide a reference point and framework for the exercise. The objectives also focus attention on the outputs and achievements required by the company.
- **Select and inform any personnel** who will act in a part time or temporary role during the project. This process is used to schedule the availability of key specialist human resources to support the team throughout the duration of the project.
- **Train the team** in both the process of VA and also in basic team building activities. It is important that all members understand the nature of the project and its importance. The initial team building exercises are also a good way of understanding the attitude of all members to the project – especially those with reservations or a negative attitude to what can be achieved. As with most team exercises there is a requirement to allow the team to build and bond as a unit. It is often difficult for individuals, drawn from throughout the factory, to understand the language that is used throughout the business and also to understand the 'design to market' process when their own role impacts on a small section of this large and complex process.

2.2 Stage 1 - Orientation Phase

The next section will concentrate on the selection and development of the VA team and on the selection of the product. It will also provide an overview of the implementation stages as summarised in the diagram below.



2.2.1 Forming the Value Analysis Team

If it is accepted that costs accumulate from the design office all the way to the customer and that this is not the fault of any individual then the VA process can be used to build a proper and effective system of control. Adopting the 'company-wide' perspective for VA activities is therefore critical if real financial and efficiency savings are to be made across the business. Seen in this way, VA will address losses in the factory (such as slower than expected processing times, poor quality and excess material loss during conversion) as well as more tangible costs that lie outside the factory (warranty returns and customer complaints etc.). In order to respond to this total approach, any business that uses VA will need to create a team of employees that represent areas in which these costs arise (it should be noted that these costs may arise in one department but be caused by another). The development of the cross-functional team will be important to generate an understanding of the 'cause and effect' relationship between sub-optimal designs, value generation and product margin.

A formal and systematic Value analysis approach involves many employees within a single business each contributing to the solution (value at lowest cost). The exact make-up of the Value Analysis team will depend upon the company, the resources that it has available and the objectives of the programme. Ideally, the team would include any stakeholder in the product design and manufacturing process from within the company as well as external representation (customers and suppliers) that has an impact or is affected by the costs of poor design.

Within the business, the team should be drawn from people that have an impact on the costs of the product. Many of these employees will be drawn from technical, skilled and managerial staff. This type of employee tends to have a good understanding of the product and the failures associated with the product from their functional perspective. These individuals also tend to understand what solutions could be used to overcome these difficulties. The team members should therefore be drawn from all the relevant functions within the business and hopefully result in a mix of personalities. In addition to specialist skills, the team requires individuals with more generalist skills in order to get the right mix of individuals. These generalists tend to be invaluable and ask simple basic questions that are often provoking to specialists who have grown accustomed to the product problems in their area. The generalist is therefore a powerful addition to the value analysis team. The combination of these specialist and generalist skills is important and the collective ability of the team will determine the quality of the results associated with VA improvement project. It is therefore important that this stage, in the implementation process, is planned carefully such that the best human resources in the business can be directed to the VA project. It may seem illogical that the best resources are used by the project but a VA programme is an investment made by the company to minimize the costs of a product and therefore the project requires the best skills that a company can afford. It is therefore important that the collective members of the VA team must possess the right skills, have access to the relevant information and be capable of working as a team in a thorough and professional manner. The typical representatives involved in a VA team would include:

- **Designers** due to the responsibility they hold for the product itself and their knowledge of design activities and the decisions taken at the early stages of the product lifecycle (specifications, materials selected and the constraints this imposes on other departments and in the business).
- **Manufacturing engineers and production engineers.** These employees have a ‘natural’ requirement to be involved with the VA process as they have a direct impact on the ability to make a product efficiently and cost effectively. These people determine how the product is to be made. Other engineering related personnel could include industrial engineers and production managers who have a responsibility to manage the process and therefore are concerned with the reduction of conversion costs.
- **Purchasing specialists.** These employees have a detailed knowledge of the purchasing requirements that result from a product design and convert these design requirements into material specifications. As such, these employees have an interest in where materials are sourced including what alternatives have been suggested by existing suppliers to the business.
- **Operational staff**, those people who actually make the product or deliver the service represent a vital source of information especially concerning the difficulties and problems associated with manufacturing and assembly.

It should be emphasized that teams need to be created as quickly as possible and may need to be trained in general team skills to assist the development of this cross-functional group. As previously mentioned, team-building exercises may be used, external facilitation may be sought and teams may also become co-located to assist the team development process. One of the first activities conducted by the team, as an introduction to the VA process and also to commence team development, is to understand and ‘walk’ the process from product design

all the way to product dispatch. This group activity allows every member of the team to understand what actually happened in the process of product conversion, to meet the people involved in the process and to understand their individual problems and general product concerns. For many of the team members this process will be novel and an activity that they have not conducted for some time (in some cases the individual has never followed a product from materials to shipment). At each stage of this tour, the team member concerned with the stage of conversion should provide an overview of the activities in the area but operational questions should be addressed to those employees that are observed working in the area.

2.2.2 An Extended Team Approach

A purely internal VA process is limited in that improvements can only be aimed at the processes within the factory. As companies engage in greater levels of purchasing from suppliers, then the relative percentage of supplied costs to the overall cost of the product rises. This implies the need to enlist the support and participation of suppliers but also to complete the process and involve customers, too. The integration of suppliers has proven to be a major advantage for companies such as Japanese manufacturers who actively seek the involvement of suppliers during the total design process of products such as electronics and automobiles. Indeed, for many Japanese companies, the suppliers are deliberately organized into groups to allow an efficient and effective process of supplier engagement. This group approach allows a much greater level of participation and dynamism to develop with and between suppliers as they work together to solve common problems. The integration of suppliers and customers offers many additional benefits to the VA process teams:

- **Customers** tend to be poor at articulating and summarizing the value they get from products and services but when integrated into a project tend to be able to offer a greater insight into their real intentions. As such the solicitation of customer information is key to a successful VA process although it should be recognized that the customer need not be involved in the full process but contribute to the early stages of product value definition. Working with customers is a comparatively difficult process, in relation to working with suppliers, and therefore the integration of customers into the VA process requires a good working relationship between the company and its customer. This working relationship is important if the customer is to understand the VA process and the benefits of improved value as opposed to simply using the process to reduce the price of the product supplied for its own purposes. Engaging customers implies that the use of bargaining power is suspended and that gains can be shared between the two parties in an equitable manner. As such, it is common to find customer integration within the VA process when partnerships, high trust relations exist, or the supplying company provides a strategically important part to the customer.

- **Suppliers and subcontractors** tend to know more about their products (and substitutes) than the purchasing business from a technical, applications and commercial. Also, tasked with greater responsibility for the design of products, these suppliers will tend to make better designs both in terms of cost and functionality. Indeed many suppliers perform services that were considered to be ‘non core’ activities and therefore many of the skills that were previously retained to design and make these products are no longer within the business. In addition, the specialist suppliers of materials or parts, tend to be capable of working autonomously without the need for close supervision and team support. This

allows the purchasing organization to reassign valuable engineering resources to support weaker or less competent suppliers. Indeed, where suppliers can work autonomously with the need to attend project review meetings only, then there is the opportunity to engage in concurrent engineering and to collapse project times to a minimum. This ability to re-engineer products, by parallel and concurrent engineering actions taken by many suppliers, provides a significant competitive advantage in terms of getting products to market before the competition.

In the current competitive environment there is little to gain by a company that continues to treat its suppliers as adversaries and to withhold information from suppliers. The integration and focusing of suppliers on the need to improve final product value and cost effectiveness is therefore an issue that necessitates the integration of suppliers as extensions of the factory team. No supplier can ever know enough about the company it supplies and the products in which its products feature. Suppliers should be considered as extensions of the main factory and just like any other manufacturing cell. As such, if this approach is taken to the many suppliers of materials and parts, then it follows that collaboration with the supplier is the most effective means of improving value whilst reducing waste and costs.

Useful Techniques for team orientation:

- Tour of the facility to understand and map the process of design to manufacturing.
- Visits to selected customers to understand the use and value of the product for the customer. A tour of the customer facility should be conducted, interviews of key personnel at the customer site and an understanding of the current problems and future requirements of the customer.
- Team building exercises can include short presentations of the role of each department by team members.

2.2.3 Selecting the Product

Once the size and make up of the VA team is determined and roles have been established then the next stage is to determine which product, or product family, will be the subject of the study. Essentially, VA can be applied to any product however certain commercial attributes will make the VA process more commercially important and potentially profitable to the business. The criteria and attributes that can be applied in the product selection stage include products with:

- **known problems** or those that have generated complaints or costly warranty returns. These products have attracted criticism and frustration from the customer to the point that the customer has formally complained. As such these problems need to be corrected as they compromise the perceived value of the customer. Products with known problems within the factory are also important, as these products require high levels of internal rectification before they reach a standard suitable for dispatch to the customer. For many businesses, the latter is a key motivation as high levels of internal corrective actions that consume costs but generate no true value for the customer or the business subsidize good customer performance. To illustrate this point, it is common to find many businesses that invest heavily in rework and final inspection routines to ensure high levels of customer quality. These activities are unnecessary costs that are often traced to poor design control and review rather than poor equipment reliability. As such, the manufacturing personnel

will never be able to take preventative actions to correct the poor quality problems and it is these products that offer high potential savings to be achieve by a VA team.

- **forecast sales volumes that are due to rise,** grow or maintain a high level of sales. These products are attractive for VA activities as they represent key products to the business. In terms of classification these products are often termed 'runners' as they feature regularly each week in the production programmes. Conversely, infrequent product manufacturing cycles of products with low annual sales tend to be called 'strangers' and these products do not tend to offer the same ability to make substantial savings from minor improvements due to the lack of volume and economies of such volumes. Existing high volume products are therefore attractive, as the volume of sales of that product to yield very large savings and efficiencies will multiply a small financial saving per unit. The logic here is that the VA systematic approach is likely to result in the reduction of costs in 'running' high volume and high frequency of manufacture products. These products by their nature have left the 'uplift' stage of new products but not yet entered the decay stage of the product lifecycle so there are many opportunities to make big returns to the company. Products that are made very infrequently do not offer this form of saving.
- **below average margins**. Products that have poor or negative profit margins would attract the attention of VA teams, as they do not contribute to the long-term survival of the business.

In reality, the selection of the product will be based on criteria that is specific to the business but it is preferable to start with a product that is sold in volume at a profit rather than attempting to correct a product that does not make a profit. The latter product is likely to be sold in low volume and would require better skills than the first VA project team have at their disposal. Therefore these 'loss-making' products are better left until the skills in the factory have improved. Having selected a product, or product family, the next stage of implementation is to understand the physical product itself, its function or value and its costs.

2.2.4 Preparation

To understand properly the function of a product the team must experience the product and this stage is important for both team building and creating a common understanding (including a common language) regarding the different components of the product under study. This is the first stage in functional analysis and provides a product overview for the team. It is essential that the team spends time getting to understand the product and how it travels through the factory as this information will provide the skeleton upon which later analyses will build and refine the details of the product functionality and costs. This stage is therefore a 'gathering' stage where the team will be expected to collect basic information about the product under study. In this preparation it is beneficial to get the team to collect and display items such as:

- **A fully assembled product.** The finished product is placed on a table and allows the team to study the product that is presented to the customer. It is common to find that, in the process of understanding, the team uses identification labels to highlight (and provide the correct name for) elements of the product. As such the working parts of the product can be identified and used as a reference for the team. To illustrate this process, the identification of key elements of a computer printer may highlight the On\Off switch, indicator lights, power-input socket, paper trays and such like.

- **Product sub-assemblies.** The finished product allows the team a limited amount of product knowledge therefore it is desirable to collect sub-assemblies for analysis. In the case of the computer printer, this may include the inkjet cartridge carrier system, the drive mechanism, the power transformer system, and such like. Once again these items will be displayed and identified with their correct names.
- **Product Parts mounted on a board.** For each sub assembly the team may build an 'exploded' bill of materials list and in the same way as before, the product will be dismantled, separated and identified. In the case of the inkjet printer cartridge carrier this may include such items as the printer cartridge holder, retaining clips to hold the cartridges in place, the communications cable, and the printed circuit board control unit.
- **Examples of raw materials** such as polymer plastic, steel sheet, aluminium profile and such like.
- **Examples of scrap produced at the various stages** of the manufacturing process. These items provide valuable insights into the causes of waste and the hidden costs of poor design or poor operation.
- **Competitor products**. These products are ideal and should be displayed for the team to review and compare rival systems with the systems that are used in the focal product. As such, the cartridge system can be compared with the system in the rival product. Ideally, the competitor product would be displayed in the same manner (the final product, sub-assembly and parts), as the focal product has been prepared.

Obviously, the collection of these support materials is greatly enhanced when the team is co-located in an area where these items can be displayed and examined properly. At several companies visited by the author, the team area has often been located near to the production process and in full display of workers as they pass the area. This allows interest to be maintained and also tends to encourage comments from line workers regarding innovative ideas or problems that they experience with certain sub assemblies or parts. In addition, it allows meetings with employees to be conducted in a central location and does not create a disturbance to the normal working day of people involved with the VA process. The visible nature of the team and their activities is a good way of promoting the initiative and serves as a good communication device as opposed to locating the team in a distant and secluded part of the building. It is also a central position when conducting senior management reviews as the area represents a visual storyboard of the history of project and its progress.

In addition to the physical product requirements of this initial stage of gathering, it is also worth collecting as much supporting paperwork as possible. Items such as the following are useful documents to have for reference:

- **The original design brief**. This specifies and provides a summary of the product design criteria and allows the historical decisions regarding the product to be seen in context.
- **Cut away drawings**. These forms of diagrammatic and pictorial documents are useful as they can be used to support the physical understanding of the product under review.
- **Costing information collected from the accounts department** is useful as it reveals how the costs are theoretically accumulated from materials, conversion, overhead application and other sources. This is a good reference and benchmark that allows improvement activities to be costed and justified.

- **Purchase specification including supplier details.** This data is provided by the Purchasing Department, it lists the key criteria and specification of materials and parts used in the conversion process.
- **Manufacturing process schematic.** A diagram, routing information or cartoon of the manufacturing process is useful as it allows the team to understand the movement of materials through the factory. The diagram also allows notes to be added to the diagram (often in the form of Post-It notes to identify critical areas, bottlenecks and processes with poor quality yields).
- **Manufacturing quality loss charts.** These operational charts reveal the sources and frequency of losses and additional cost accumulation in the conversion process. These charts may also include the problem-solving charts used by teams in the area to highlight the key causes of failure and the quantification of the number of product failures.

In summary, this first stage of the team development and data collection and the team should invest an appropriate amount of time collecting and generating this basic set of information requirements. It should be noted that many companies will have the information needed by the team but not necessarily in one place or in the format required by the team. It is important that this information is collated and stored centrally, as these are vital reference documents that will form part of the closing report stage of the project.

Useful Techniques for the preparation stage:

- Team brainstorm of project requirements, critical path, losses at each stage of the design to customer process.
- Refinement of the detailed product-process map (the recording of the stages of the process with comments related to costs, quality and known problems at each stage.
- Development of the cause and effect, bar chart of problems and pareto analysis of failures in the conversion process. Development of Failure Modes Effect Analysis chart (FMEA).
- Development of a chart that displays the process and costs of each process stage to demonstrate the points in the conversion process that generate the most costs.
- Review of customer complaints (or survey) with associated cause-and-effect and pareto analyses.
- Benchmarking information where available or practical to collect.

2.3 Stage 2 - Functional Analysis[1]

The next stage of the VA exercise is to commence the analysis of the product by identifying systematically the most important functions of a product or service. This is known as functional analysis. ‘Function’ can be defined, as the use demanded of a part pr a product and the esteem value that it provides. These functions therefore make the product work effectively or contribute to the ‘saleability’ of the product. Functional analysis outlines the basic function of a product using a verb and a noun such as ‘boil water’ as in the case of our kettle. These are several steps within this stage:

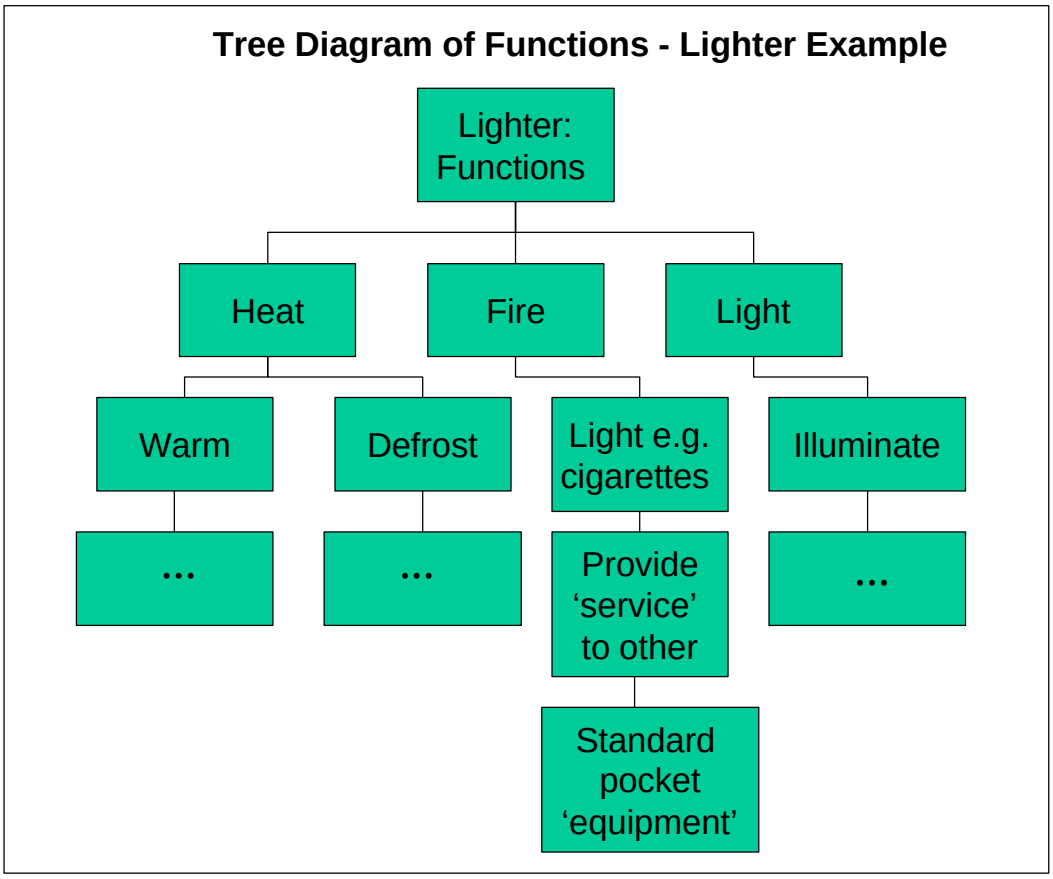
[1] adopted from Bicheno, 1998

A. Describe the Functions

The first step is to systematically analyze and describe the functions that the product undertakes. The basic functions of the product or service are listed, or brainstormed out. A function is best described by a verb or noun, such as ‘make sound’ or ‘transfer pressure’, or ‘record personal details’. The question to be answered is ‘what functions does this product/service undertake?’. Typically here will be half a dozen or more activities. There is a temptation to take the basic function for granted, but do not do this, as working through them often gives very valuable insights into the value and functionality of the product and nothing should be taken for granted by the team. For instance, for as domestic heat time controller, some possible functions are ‘activate at required times’, ‘encourage economy’, and ‘supply heat when required’. This is often a slow but enjoyable stage of the VA process and it is not an activity that many of the team will have experienced before. Once again, it is important to document all discussions and team exercises for later reference.

A customer requires two types of function in any product or service: ‘work’ functions and ‘sell’ functions. For instance a postage stamp has the work functions of ‘authorize carriage’ and ‘evidence of payment’, and sell functions are ‘attract identification’ and ‘allow collection opportunity’. The team should brainstorm these ‘work’ and ‘sell’ functions of the product. It is useful to brainstorm these issues using Post-It notes and to record the results of this exercise on a standard form for this activity. Some of the key issues for checking are listed in appendix A.

It is important to take time during this stage because the most important function is not always immediately clear and an inappropriate choice, by the team can lead to a very different solution. It is therefore important to enlist external support and facilitation if the team is inexperienced. The functions discovered by the team can be grouped and recorded using the Tree Diagram approach, also known as the FAST method (Function Analysis System Technique) in VA. FAST or Tree Diagrams allow the ideas of the team to be structured and recorded in a logical manner (see chapter 3.2 for further explanation).

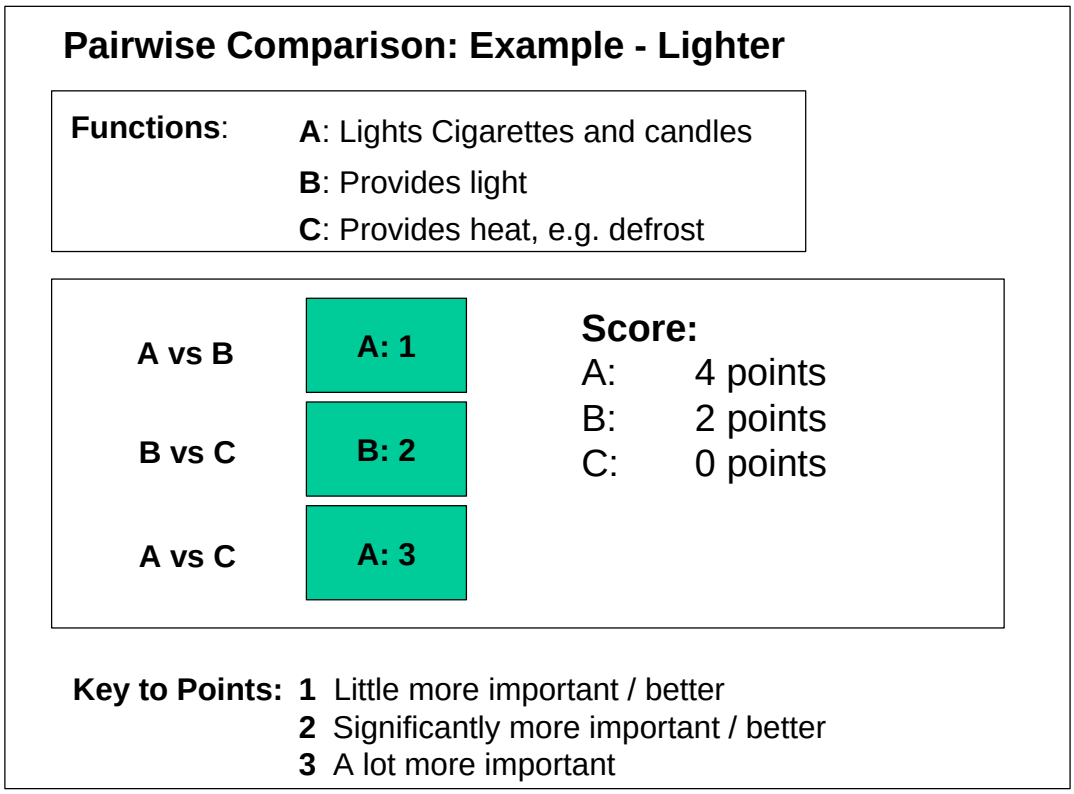


B. Rank the Functions by pair-wise Comparison

The next step uses pair-wise comparison to rank the functions. This is often done as a group activity, reaching a consensus about each pair. It works like this: each function is compared for importance with each other function, using e.g. a table (see figure). The most important of the two functions is identified and written on the table. Always decide which function is more important, do not allow the 'cop out' of saying that both are equally important.

Then the group decides if the difference in importance is minor (1 point), medium (2 points), or major (3 points). The group discussion on importance usually makes this easy, and points made are written on the table. After all pairs have been compared, the scores for each function are added up – the higher the score, the more important the function.

Experiences here show that in most studies one or two functions emerge as being by far the most important ones. These functions are those to concentrate subsequent efforts on. This stage of identifying the most important or 'basic' functions is very important from the point of view of gaining group consensus.



Useful Techniques for Functional Analysis:

- Structured tree diagram analysis.
- Strengths, Weaknesses, Opportunities and Threats analysis (SWOT).
- Quality Function Deployment chart development to understand customer 'wants'.

2.4 Stage 3 - Creative Brainstorming[2]

This step requires a certain amount of creative thinking by the team. A technique that is useful for this type of analysis is brainstorming which allows all the members of the team to participate and for some strange yet ultimately commercial ideas to be promoted amongst the team. This stage is concerned with developing alternative, more cost effective ways of achieving the basic function. All rules of brainstorming are allowed, and criticism needs to be avoided as it could cease the flow of ideas. Simply list down all ideas, not regarding whether they sound apparently ridiculous. Various 'tricks' can be used, such as

- **Deliberate short periods of silence**. These deliberate periods of reflection allow the team members to refocus their thoughts and to avoid the trap of following one line of thought to far.
- **Writing ideas on cards anonymously**. This approach is particularly good for team members who are shy or feel inferior to the specialists in the group. Using this approach each team member is issued with a number of paper cards and uses these to write down

[2] Op cit

their ideas. At a point in time, all the cards are collected, discussed and grouped. This is a good way of gaining high levels of participation from the entire team.

- **Sequencing suggestions in a 'round-robin' fashion**. This process involves the team situated at a table. Each person nominates an idea for the team and then the responsibility passes to the person on his or her right. As the process unfolds, several cycles of the entire table will produce a large number of ideas which will eventually become exhausted. Therefore the team will amass a great quantity of ideas for discussion in a relatively short time period.
- **Making sketches**. Many of the specialists in the group will be more comfortable drawing their ideas rather than verbalizing them. This is true of engineers who find verbalizing complex solutions difficult but drawing them somewhat easier. In this process, the teams are allowed to draw potential improvement ideas for discussion.
- **Explaining the product to an 'extra-terrestrial' customer**[3]. This process is interesting and somewhat challenging, as the team must describe the functionality to a person that has no concept of the product or its application. This process sounds very easy but in reality is quite difficult as the team will constantly review their efforts to describe the product and therefore add greater and greater levels of detail that often go unexpressed. This process usually involves a high degree of humor and is a fun activity that ensures everyone in the team understands the functionality of the product. In effect, this process creates a common understanding and a baseline that can be shared with all team members regardless of their level of specialist knowledge.

These techniques have been proven to generate high levels of enthusiasm, high levels of participation and also a high quantity and quality of innovation. The real key is to make the process fun and allow individuals to 'spark' ideas from their other team members. It is also a good way of 'becoming the customer' and undertaking a critical review of value by looking at the product in a neutral manner. It should be noted that many people have unrealistic expectations of this process and expect radical innovations in product design and often this is not the case. Breakthrough innovations are possible but it is more important to improve in the right direction and allow the team to 'up-skill'. As such, any improvement in cost effectiveness is a worthy result and one that benefits the company – a major radical breakthrough is either the result of new innovations that are available since the design of the product or other factors. In addition, a radical innovation implies that the initial design of the product must have been particularly poor and this is seldom the case. Designs tend to be more or less right and are always capable of improvement towards the optimal cost stage.

2.5 Stage 4 - Analysis and Evaluation

The third stage is to evaluate the 'cost' and 'worth' of each function. This is not an exact process but allows the existing cost of the product to be apportioned between the functions based on the assumptions that have been made by the team. The worth is determined by estimating the lowest cost of producing each basic function if cut down to its minimum. The **value potential** is therefore the difference between the cost and the worth figures. In some cases it might be necessary to for the team to take a break while specialist team members, or seconded resources, evaluate the costs and feasibility of some of their suggestions that have been generated.

[3] Humor can foster this stage to a great extent.

At this stage, the options available to the team are therefore to modify the design of the product to:

- **Completely eliminate the part** from the design as it serves no useful purpose and has no customer value but only a cost.
- **Replace, substitute or modify the part** and therefore lower the cost of the product by making an improvement to it.

The results of these team deliberations and evaluations of the different alternatives and potential changes can be recorded using a cost-benefit chart. This chart displays the costs of the improvement on one axis, and the associated benefits along the other. At this point the team has developed and justified improvements to the product and this stage usually concludes with a project report with recommendations. In addition, the team will develop a brief presentation to senior management as a summary of their findings and recommendations. The presentation and report will usually contain the following sections:

1. The subject, product and VA project team brief mandated by senior management
2. The business conditions and justification to improve the cost performance or value enhancement of the product.
3. The current costs of the product and the failures in the conversion process that represent the hidden costs of poor design.
4. An analysis of the product and its functionality for customers.
5. The proposed changes and the commercial reasons for it.
6. The comparison of actual costs now and post-implementation costs.
7. The savings year on year based on future expected volumes.
8. The expenditure items required.
9. The process of implementing the change and the proposal (including timing of the different phases)
10. A list of issues that could not be resolved by the team but are worthy of future analysis.
11. A complete list of appendices containing all the materials collected used and recorded during the lifecycle of the team.

The next stage is to gain a formal agreement by the senior management team to proceed and schedule the timed implementation of the recommended changes.

2.6 Stage 5 - Implementation

The final stage of the VA team is to report the findings to the senior management team and to gain permission to implement the findings of the report. This is the most rewarding stage as the many hours of brainstorming; classification and calculation begin to become ‘the new product’ and ‘the new way of manufacturing’. At this point, each product or service that is conducted is done so with the knowledge that it generates profit for the business and generates value for the customer in the most effective and efficient way. It should be noted that changes need to be scheduled in order to prevent ‘change overload’ within the factory whereby many elements of a product are replaced or modified and also to allow specialist departments such as the Purchasing Department to make the necessary changes to material and part specifications. These activities need to be phased to avoid the chaos of multiple

changes happening at once and to allow the anticipated cost savings to be tracked and monitored. Indeed, it may be necessary to track the improvement in the quality performance of the product (in the factory) over many months before the improvements can be proven to work. This is especially true where the company has to run down the existing stocks of the problem part before introducing the modified part.

2.7 Cases of VA Success

- A manufacturer of domestic water heaters conducted a VA analysis. It found that the customer derived value from the cost efficiency and reliability of the product. In addition, the company found that the largest source of failures resulted from internal moving parts that failed frequently. The VA exercise resulted in a decrease in these moving parts (valves etc.) and a replacement of other problem items with more cost-effective alternatives. The reliability of the product has resulted in no complaints from customers and a reduction of moving parts to only three parts.
- A lighting company has achieved savings of 6 times the costs of its value analysis exercises. One product has achieved a 250% increase in sales over its predecessor. Now the company has trained over 15% of its workforce in VA techniques.
- A small company producing cooling radiators for machinery, involved its suppliers in the redesign of the existing product range with the result of a much better product and half the conversion costs of the previous product sold to the market.
- An office stationary company conducted a VA exercise on a range of paper stapling devices and hole punching devices. The team found that the traditional designs had always incorporated metal as the main material. After several exercises that looked at the way in which the products were used and also the function required of the product, the company converted the product from metal to a plastic design at a major cost saving.
- Toy Company redesigned a model product, as a result of a VA exercise, and reduced the many different metal fasteners with just one type creating a saving for the company and the supplier.

3 ADDITIONAL INFORMATION

3.1 Regional Assistance

There are many agencies and institutes that exist to improve the performance of small and medium sized businesses in different regions of the European Union. Whilst it wold be impossible to list all these agencies and the important work that they offer to assist companies it is worthwhile providing an analysis of how these agencies can be utilized in the VA process:

- Awareness raising workshops.
- Implementation workshops.
- Honest brokers of information, advice and access to other companies that are more advanced in VA activities. This facilitation role is important if the company is new to the process of VA and good initial advice and guidance is critical to the success of the VA exercise.
- Finding local sources of supply for components and materials.

There are many web sites that provide good insights and overviews of the VA process. One of the best sources of additional information can be obtained from the web page of the UK Department of Trade and Industry. http://www.dti.gov.org

3.2 Related Tools and Techniques

This section briefly describes tools and techniques that have been identified by this report. These references may provide useful 'signposts' for companies that are considering which tools to use during the process of VA.

Product Platforms
Platform designs offer a high degree of standardization as well as the ability to customize products in the final stages of manufacturing and assembly. This maximizes the number of core items and allows a business to 'create' new products with minor modifications. The benefits of this approach are economies of scale associated with core parts, the familiarity of workers through repetitive assembly of these parts thereby gaining efficiency and finally the small inventory requirement to enable customization. An example of a platform strategy would include the development of a stapling device that has an universal pressing mechanism but has a colour-coded outer cover that allows the product to be customized to the requirements of the purchaser. Another example would be a car company that has many common parts between vehicle ranges (all cars of the same size) but customizes the product to order at the latest possible stage (i.e. adding the specific customer requirements such as air-conditioning, CD player, anti-lock brakes).

Concurrent/Simultaneous Engineering, Participative Design/Engineering
A practice that involves the participation of all functional areas of the firm in the product design activity as a means to compress the time between concept to launch. Suppliers and customers are often included. The intent is to enhance the design with the inputs of all the key stakeholders. Such a process should ensure that the final design meets all the needs of the stakeholders and should ensure a product that can be quickly brought to the marketplace while maximizing quality and minimizing costs. Synonyms are co-design, concurrent design or engineering, parallel engineering, simultaneous design/engineering, team design/engineering. In the case of a company that manufactures telephone systems this practice reduced the time from design to sales in the market by one third of an existing product.

Quality Function Deployment (QFD)
A methodology designed to ensure that all the major requirements of the customer are identified and subsequently met or exceeded through the resulting product design process and the design and operation of the supporting production management system. QFD can be viewed as a set of communication and translation tools. QFD tries to eliminate the gap between what the customer wants in a new product and what the product is capable of delivering. QFD often leads to a clear identification of the major requirements of the customers. These expectations are referred to as the voice of the customer. For related topics see also 'House of quality'. This technique, that was developed by Mitsubishi Heavy Industries to design ocean vessels, has been used with tremendous effect by electronics and automotive companies although the technique is now popular in other sectors.

Process Mapping
Process mapping is a step-by-step analysis of the design to customer process. At each stage in the process, the team record the activity, its duration, the number of people involved and any comments related to the process (especially any costs or failures at that stage). Each stage is listed as the process happens and the chart provides a good means of analysing what happens to the data and physical product as it moves through the business. The completed chart also allows the team to identify stages that can be eliminated, reduced in duration, or those that cause the greatest amount of problems. The purpose is therefore to understand the process and to streamline it. This chart also allows a flow chart to be produced as a standard operating procedure to control the process in the future. An associated technique, an evolution of the flow chart that is used by many advanced VA companies is 'four fields mapping'. This technique plots all the stages and tasks associated with the design process against the business departments involved in the total process. It shows who is involved when and at what stage, where decisions must be taken and what standards must be achieved in order to progress from one stage to another. The four fields mapping technique is therefore both a procedure and can also be a form of project control chart.

Design for Manufacture/Assembly (DFX)
A product development approach that involves the manufacturing function in the initial stages of the product design to ensure ease of manufacturing and assembly. Since its introduction, the concept has been extended to design for 'remanufacture' or even design for 'supply chain management', involving suppliers in the design stage. It is generally referred to as DFX. As most of the design weaknesses of a product become visible in the production process this approach and set of techniques can result in very large savings in efficiency, time, and also quality losses.

Design FMEA
Design Failure Mode Effects Analysis (FMEA) is a procedure in which each potential failure mode in every sub-item of an item is analyzed to determine its effect on other sub-items and on the required function of the item. This approach is a means of identifying the sources and frequency of failure in order to prevent (or to target) areas of weakness in the product design.

Kano Model
The Kano model relates three factors (which Kano argues are present in every product or service) to the degree of implementation. Kano's three factors are 'basic' (or must be), performance (more is better), and delighter (excitement factors). The degree of customer satisfaction ranks from disgust, to neutral and finally delight. This technique is best illustrated by a product such as a computer printer. At the basic level the printer must be safe, in terms of performance it is typically measured in a number of pages per minute and an excitement factor could be that the printer can also receive fax transmissions. It should be noted that these basic, performance and excitement factors that represent value are not static and what was once an excitement factor will often become a performance factor over time. Take motor cars as an example, once central locking, airbags, and ABS systems were excitement factors – today we take forgranted that they are merely performance factors.

Taguchi Methods
A concept of off-line quality control methods conducted at the product and process design stages in the product development cycle. This concept, expressed by Genichi Taguchi,

encompasses three phases of product design: system design, parameter design, and tolerance design. The goal is to reduce quality loss by reducing the product's characteristics during the parameter phase of product development. This process is founded upon the experimental testing of designs. The Taguchi technique involves some complex mathematical calculations to refine the design process and to get a better, more accurate, design in less time.

Target Pricing \ Costing
This is a practice which uses a known market price (a price that the market will tolerate) as the starting point for the review of products to eliminate waste and costs as a means of generating a margin for the product. This process provides a good objective for product designs and increases the 'price' attractiveness of the product in the market. It is therefore a good means of focusing the design process.

Product Variety Funnel
This is a diagram that shows, for each stage of manufacture and conversion, the number of products that result from a single input (in the form of a line chart). For example, a car company may start with a basic hatchback vehicle, once it is painted there may be 14 different types of this vehicle, then one of three engines can be added (expanding the funnel by a factor of three) and so on throughout the production process. As such, it is common to find that many car companies actually offer 90,000 different variants of the one input. This diagram provides valuable insights into the ability to configure vehicles to order and indicates the point at which the funnel expands rapidly. Anything to the right of this point indicates that the product is specific and to the left it is relatively flexible to be used in a number of final products. This technique has obvious links to customisation, platforms and time compression methods.

Cause and Effect Analysis
A tool for analyzing process dispersion. It is also referred to as the Ishikawa diagram and the fishbone diagram. The diagram illustrates the main causes and sub-causes leading to an effect (symptom). The cause-and-effect diagram is one of the seven tools of quality. This technique is often termed the 'fishbone' diagram as the chart resembles a form of skeleton. This is a great way of collecting information regarding failures of a product in the manufacturing process by segregating failures into distinct themes such as materials, methods, people, and such like.

Check Sheets
A simple data-recording device. The check sheet is designed by the user, which facilitates the user's interpretation of the results. The check sheet is one of the seven tools of quality, and should not be confused with data sheets or checklists. The person conducting the analysis therefore monitors and records each time a failure is detected. The number of failures is often converted into a bar chart to show the amount of failures by the source of the failure. Also, it is common to then convert the bar chart into a pareto chart (an 80:20) chart that shows the most important sources of failure. The rule of thumb applied to pareto analysis is that 80% of the frequency of failure can be traced to only 20% of the sources of failure. Therefore targeting the 20% of sources will bring immediate and effective results for the redesign of the product.

Tree Diagram (FAST)

A tree diagram is a tool to systematically decompose customer requirements or other goals into a logic heirarchy. In the case of VA, the starting point could be the customer requirements for value. From this box a series of arrows would extend to all the different functions that create value for the customer and then each one of these would be broken into sub-elements as the chart is drawn. The chart is therefore a carefully layered series of relationships. The chart is very useful when analysing complex situations such as under VA conditions, it constantly refines and specifies what is needed at each level or tier of analysis to achieve the starting point goal. The technique also reduces the time required when conducting analyses. On completion, the chart represents the entire list of variables that need to be analysed by the team. The technique is also known as FAST for VA purposes and this acronym stands for Functional Analysis Systems Technique.

Computer Aided Design (CAD)
This process involves the use of computer generated designs for flexibility during the product design stage. It allows the designer to make, test and revise drawings before they are released to the manufacturing department. The use of computer based designs also allows the process to evolve into computer aided manufacturing (direct computer to machine manufacturing), rapid prototyping via disk or downloaded information and the ability to export data (and drawings to suppliers).

4 SUMMARY

This publication has provided an overview and insight into the Value Analysis process. No Company can take seriously Total Quality Management without operating a formalized system of Value Analysis. No business that wishes to become lean will ever succeed if product designs remain unchanged because no amount of continuous improvement in the manufacturing process can release the costs of a poor design or a design that has not changed for many years.

However, poor product reviews or an informal process, that is restricted to only to a review of the design by the design department, will yield only limited success in eliminating ‘avoidable costs’. These efforts will miss the many opportunities to make manufacturing and assembly easier, quicker, less complex and less costly. Thus margins will not be improved significantly because only a small part of the total process has been managed correctly. As such, this type of superficial activity will not generate increased profit and the revenue stream that will be needed to finance new products and new investments in technology.

A properly managed and effective VA process will easily repay the time invested by managers over the life of the product and a truly effective process will yield significant competitive advantage for companies that exploit it. For businesses that supply other organizations, the ability to design and redesign products opens the possibility of true, meaningful, profitable and long-term partnership with a customer. Each progressive step that secures a greater design responsibility for the supplier will, in parallel, make the supplier increasingly more important to the competitive advantage of the customer organization and will increase the benefits to both companies.

In an environment where budgets are often reduced, the market determines the selling price of a product and consumers demand a greater variety of products, VA is one technique that

companies cannot afford to ignore because for every day that the technique is not employed is money that will leave the business forever. Money that cannot be recovered once the product has been sold.

The benefits of a formalized and effective VA process are therefore many and include some key sources of competitive advantage for any business including:

- **Speed of getting an effective design into the market** without problems and through error-free manufacturing and assembly processes,
- **Reliability and durability of the product** in the market which enhances the reputation of the product and the company,
- **Low overall cost** which enhances product margin and also releases finances within the business as well as allowing the ability to engage in price competition,
- **Enhanced quality and compliance** with minimal costs of warranty that allows a company to differentiate its products based this perceived quality (of use and esteem).
- **Differentiation by creating product designs as platforms**, which facilitate 'last minute' or late configuration of the product to meet customer, orders regional preferences or any other geographical constraint (such as product laws of a certain region).
- Finally, the VA process satisfies the primary goal of any business – **to make a profit and survive**.

As a process, VA is very robust and offers tangible, financial and people-based benefits. The process eliminates unnecessary weight, it removes unnecessary costs and importantly it allows people to understand products, processes and continuous improvement. Very few modern management techniques allow this form of participation and involvement and even fewer have such a profound impact on the bottom line of the business's trading accounts. For companies that do not employ this technique, there is one very frightening thought, that for every product that the company makes one or two may be bought by competitors and subjected to value analysis. Therefore, these competitors can easily recover the ground lost to any 'breakthrough' new product with half the effort and half the expense of starting from the beginning. These competitors can also take the new product and 'streamline' it to offer maximum value at minimum cost thereby creating a new product without any real expense. This is perhaps the most frightening though of all.

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Annex
Issues to be checked for Functional Analysis

A. Function

The following list of issues should be considered during this stage:

1. Analyze the basic function and secondary functions of the product, sub assembly or part
2. Differentiate between use and esteem value. When attempting to analyze the component parts of a product it is preferable for the product to be dismantled. The purpose of this activity is to understand the entire product by looking at the individual elements. Once the parts level of the product has been established (through this 'strip down' activity), then each part can be classified by the team. It is often helpful to use the following analysis:
   - Classify parts as 'A' if they are essential to the functionality of the product and give value to the customer
   - Classify the parts as 'B' if they provide esteem value but no real functional use value
   - Classify parts as 'C' if they are non-essential items that add no direct value
3. Question whether the functions are essential, could be eliminated altogether, could be substituted for a lower cost solution, can all or any of the functions be incorporated in another component.

B. Material Specification and Content

1. What material is used
2. Why is this material used
3. Can the materials be substituted with another, material
4. Can the dimensions be reduced
5. Oversize by calculation

C. Material & Manufacturing

1. How much of the basic material is wasted in conversion
2. What are the causes of the waste
3. Can the waste be reduced
4. Can alternative methods
5. Can the materials be provided in a different format
6. Can parts be made for many products

D. Standardization

1. Is the component made from the standard raw material
2. Is the component standard
3. Can the special parts be replaced with standard parts

E. Direct Labour Costs

1. What are the labour operations involved
2. What are the direct labour costs
3. Can a labour operation be eliminated or reduced by a minor design change, or a change in method of manufacture or improved machinery
4. Can assembly operations be reduced

F. Tolerances & Finishes

1. What tolerances have been specified and why were they specified as control items
2. What are the critical limits
3. Are all specified tolerances relaxed to ease manufacture, to allow an alternative method of manufacture or permit a lower purchase costs
4. What finish specifications were detailed
5. What finish specifications

G. Costs of material

1. What parts are bought-out?