BRITISH STANDARD

BS EN 12973:2000

Value management

The European Standard EN 12973:2000 has the status of a British Standard

ICS 03.100.40

National foreword

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The UK participation in its preparation was entrusted to Technical Committee DS/1, Dependability and terotechnology, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Summary of pages

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English version

Value Management

Management par la valeur — Value Management

This European Standard was approved by CEN on 7 October 1999.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 279, Value management - Value analysis, functional analysis, the Secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2000, and conflicting national standards shall be withdrawn at the latest by October 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The aim of this standard is to present, define and explain Value Management (VM) and to introduce the basic concepts of the methods and tools most commonly used in its application.

Historical background:

Value Management is a style of management that has evolved out of previous methods based on the concept of value and functional approach. These were pioneered by Lawrence D. Miles in the 1940's and 50's who developed the technique of Value Analysis (VA) as a method to improve value in existing products. Initially Value Analysis was used principally to identify and eliminate unnecessary costs. However it is equally effective in increasing performance and addressing resources other than cost. As it evolved the applications of VA widened beyond products into services, projects and administrative procedures. At the same time other methods and management techniques based upon the concepts of value and function have evolved such as Design to Cost (DTC) and Functional Performance Specification (FPS).

The standard is primarily addressed to three groups of customers:

- senior executives seeking to enhance value for their organization and satisfaction for their customers by using the concepts of Value and Function as the basis for making decisions;
- all those involved in the formal application of Value Management methods within specific projects including generalists and specialists;
- all those involved in Value Management development or training.

It has been structured so that the introduction outlines why Value Management is relevant to management. Section 4 explains what Value Management is and Section 5 introduces how Value Management should be applied (see Figure 1).

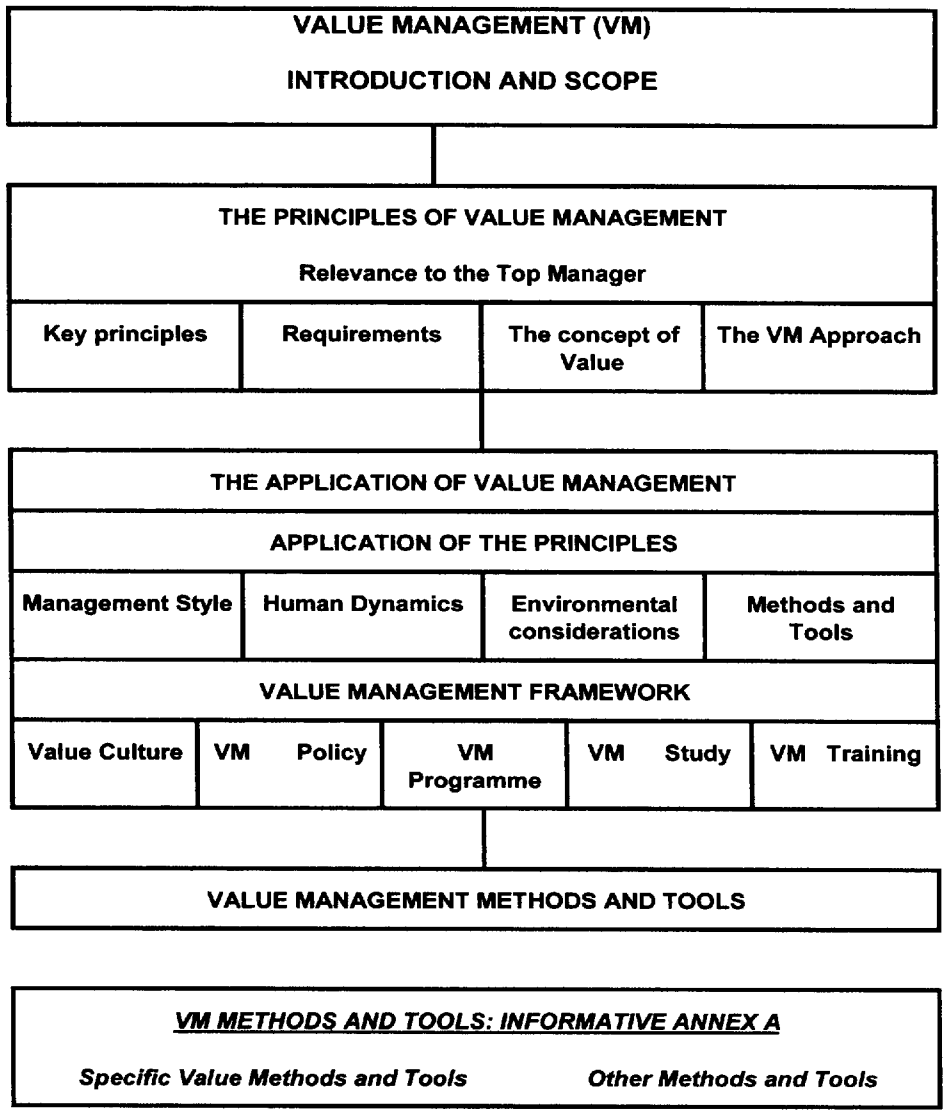

Figure 1 — Structure of this document

The European Standard on Value Management has been developed to promote unified concepts, common practice and the highest levels of expertise and efficacy throughout Europe.

This standard represents a development from previous Value Analysis standards.

It integrates the pre-standardization work, sponsored by the European Commission, with the standardization work of CEN/TC 279 and refers in particular to the standard EN 1325 "Value Management, Value Analysis, Functional Analysis vocabulary", of which Part 1 "Value Analysis and Functional Analysis" has been published.

Introduction

The concept of Value relies on the relationship between the satisfaction of many differing needs and the resources used in doing so. The fewer resources used or the greater the satisfaction of needs, the greater the value. Stakeholders, internal and external customers may all hold differing views of what represents value. The aim of Value Management is to reconcile these differences and enable an organization to achieve the greatest progress towards its stated goals with the use of minimum resources.

Value Management is a style of management, particularly dedicated to motivate people, develop skills and promote synergies and innovation, with the aim of maximizing the overall performance of an organization. VM provides a new way to use many existing management methods. It is consistent with Quality Management. Value Management has been proven effective in a wide range of activities.

Applied at the Corporate level, Value Management relies on a value-based organizational culture taking into account Value for stakeholders and customers. At the operational level (project oriented activities), it implies in addition the use of appropriate methods and tools.

For a top manager to take a decision, whether this be in the definition of commercial strategy, the development of a new product or the conclusion of a financial agreement, requires a consistent approach toward addressing these issues. Value Management simultaneously addresses management goals, encourages positive human dynamics, respects internal and external environmental conditions and positively provides the methods and tools for achieving results.

The most visible benefits arising out of the application of VM will include:

- better business decisions by providing decision makers a sound basis for their choice;
- increased effectiveness by using limited time and resources to best effect;
- improved products and services to external customers by clearly understanding, and giving due priority to, their real needs;
- enhanced competitiveness by facilitating technical and organizational innovation;
- a common value culture, thus enhancing every member's understanding of the organization's goals;
- improved internal communication and common knowledge of the main success factors for the organization;
- simultaneously enhancing communication and efficiency by developing multidisciplinary and multitask teamwork;
- decisions which can be supported by all stakeholders.

The benefits are available to providers and consumers in all sectors of society:

- the industrial sector including manufacturing, construction and processing;
- the services sector, both public and private;
- the government, health, education and other public activities.

The Value Management approach involves three root principles:

- a continuous awareness of value for the organization, establishing measures or estimates of value, monitoring and controlling them;
- a focus on the objectives and targets before seeking solutions;
- a focus on function, providing the key to maximize innovative and practical outcomes.

The approach allows the accomplished manager to apply the principles intuitively, particularly in addressing high level issues such as commercial strategy. Equally, all levels of management may apply the methods formally, in a team environment, to solve specific problems. Value Management embraces specific management tools which may be applied in a rigorous and systematic manner to address all manner of issues ranging from strategic goals to the design of one single component.

In larger organizations, it is normal to introduce a structured framework to assist managers in applying Value Management consistently across the organization. In such organizations, individuals may have specific and well defined role functions within the process. In smaller organizations (such as Small and Medium size Enterprises), such roles may be less well defined and an individual may effectively perform several of them as part of his duties.

To achieve the universal and flexible application of Value Management throughout an organization, without losing effectiveness of the approach, requires that every member be aware of the fundamentals which drive value for that organization, and take decisions on a consistent basis.

The building of a Value Management culture within the organization is fundamental. It requires training and awareness campaigns appropriate to the activities, responsibilities and accountability of the individuals.

The existence of a mature value culture will change attitudes and working practices, encouraging groups to work together and reduce confrontation. The results will be reflected in a reduction of wasted and unnecessary effort and encourage the focus of limited resources on those areas which will give the greatest value.

1 Scope

The purposes of this standard are:

- to establish a common basis for management to implement and practise Value Management;
- to help team leaders and team members to practise the methods;
- to establish a basis for developing training and certifying procedures for individual competencies in Value Management;
- to establish a basis for Value Management contractors to provide services;
- to establish a basis for certifying companies and organizations;
- to improve the quality of Value Management and stimulate innovation in its use;
- to improve communication through the use of common terminology.

This standard provides a guide to all managers to practise Value Management and to introduce this discipline within their organization, and for all other members to understand and participate effectively in Value Management.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1325-1, *Value Management, Value Analysis, Functional Analysis vocabulary - Part 1 : Value Analysis and Functional Analysis.*

3 Terms and definitions

The term "Value" has been defined in EN 1325-1. It has the same meaning in this European Standard.

For the purposes of this European Standard, the following specific terms and definitions apply:

3.1
Value Management (VM)
Value Management is a style of management, particularly dedicated to motivating people, developing skills and promoting synergies and innovation, with the aim of maximizing the overall performance of an organization

Applied at the Corporate level, Value Management relies on a value-based organizational culture taking into account Value for both stakeholders and customers. At the operational level (project oriented activities), it implies, in addition, the use of appropriate methods and tools.

3.2
Value Culture
Value Culture is an attitude, awareness and sufficient knowledge of what the concept of value represents for an organization and its stakeholders and of the factors that may affect this value

It includes an appropriate knowledge of available methods and tools and an awareness of managerial and environmental conditions which enable Value Management to flourish.

3.3
Value Management Programme
a Value Management Programme is a planned and structured array of activities which enables the development, implementation and maintenance of a Value Management Policy in a sustainable manner

3.4
Value Management Study
a Value Management study is the application of Value Management to a specific subject identified within a Value Management programme and may involve the use of one or more methods

NOTE: A Value Management study is a specific approach to a clearly identified subject. Value Management provides a set of methods that complement the Project Management methodology.

One or several specific Value Management studies may be carried out within a wider project.

3.5
Value Manager
a Value Manager is a person who is responsible for designing, developing and implementing a Value Management programme

4 The principles of Value Management

Relevance to the Top Manager

VM can then be defined as a transverse approach, a common way of devising the different management of specific areas of the enterprise (human relations, technologies, costs, ...). It focuses on the Value concept in order to validate operational objectives and to define specific strategies.

The top manager strives to obtain better outputs from the whole of the organization's assets, financial, material and human, to satisfy the expectations of shareholders and customers.

Value Management integrates the operational managers' efforts with those of higher management to provide a seamless focus on value throughout the organization. It provides this by concentrating objectively on outcomes which are in line with overall corporate objectives, in preference to local or short-term priorities.

Every manager will develop his own style of conducting his responsibilities within an overall, consistent VM culture, which embraces and encourages team work, communication and emphasis on the customer (internal or external) rather than the provider.

The resulting atmosphere encourages innovation, draws on the synergy of people working together and results in better utilization of resources to fulfil the organization's aims.

4.1 Key principles

Value Management is distinct from other management approaches in that it simultaneously includes attributes which are not normally found together. It brings together within a single management system:

- management style;
- positive human dynamics;
- consideration of external and internal environment;
- effective use of methods and tools.

Management Style

The distinctive Value Management style combines several essential qualities to ensure the application of the concepts of value and function. These qualities and concepts include an emphasis on teamwork and communication; a focus on what things do rather than what they are (functional approach); an atmosphere that encourages creativity and innovation; a focus on customers' requirements and a requirement to evaluate options quantitatively to enable robust comparison of options.

Human Dynamics

- Teamwork:
  - encouraging people to work together towards common solutions and avoiding confrontation;
- Satisfaction:
  - recognizing and giving credit for individual contributions and team results;
- Communication:
  - bringing people together by improving communication between them, fostering better common understanding and providing better group decision support;
- Encouraging change:
  - challenging the status quo to bring about beneficial change;
- Ownership:
  - the assumption of ownership of the outcomes of Value Management activities by those responsible for implementing them.

Environmental Considerations

- external conditions:
  - taking account of pre-existing conditions external to the organization over which managers may have little or no influence. These conditions may represent opportunities or constraints;
- internal conditions:
  - within an organization there will be existing conditions which managers may or may not be able to influence. Sometimes top managers can change internal conditions by changes in their organization's strategy;

- degrees of freedom:

  - the external and internal conditions will dictate the limits of potential outcomes and should be quantified.

Effective use of methods and tools

- means of achieving outcomes.

Value Management provides the framework within which established and proven management methods can be applied in a structured and logical manner. Value Management brings these methods and others together thus ensuring each is applied, not in isolation, but in a holistic approach consistent with an organization's goals.

The methods enable issues at any management level to be tackled effectively.

4.2 Value objectives in Value Management dynamics

Setting objectives and monitoring their achievement are the responsibilities of the management of an organization or of a project. The ability of Value Management to deliver significant improvements depends largely on proper management of objectives.

At strategic levels, objectives shall be specified in terms of Value and be clearly established as baselines. This will enable the formulation of detailed objectives at all levels of responsibility.

At tactical levels, a detailed objective may represent a level of satisfaction of needs, a consumption of resources or a combination of both. In any case, the links with the Value objectives that have been defined at strategic levels shall be clear and logical. At each level, agreed measures shall be identified that will make it possible to monitor the evolution of Value objectives.

To achieve maximum effectiveness, it is important that the objectives decided upon be ambitious and show a clear will towards significant improvements in terms of Value. As such, they will be recognized by responsible managers as realistic and achievable. Achieving consensus of the Value Management objectives is an essential component for efficient teamwork.

4.3 Requirements

Putting the principles of Value Management into practice is made easier by implementing a framework which includes all levels within an organization. The framework promotes an attitude of mind and regulates the use of effective concepts, methods and tools.

4.3.1 Framework

The above principles of Value Management, Management Style, Human Dynamics, Environmental Considerations and Methods are brought together in a management framework comprising:

- a Policy;
- a Programme;
- training; and
- specific studies;

all of which help to establish a Value Culture within the organization.

4.3.2 Attitudes of mind and knowledge

The successful introduction of Value Management requires that every member in the organization becomes personally involved and committed to the principles.

This may require a significant change of attitude in which all members, especially top management:

- accept that there is always scope for improvement in every aspect of the organization;
- provide active support to the introduction of Value Management in their organization;
- accept the constraints due to the approach and apply the principles rigorously;
- actively apply the concepts and approach to their specific management responsibilities and tasks.

All members of an organization, whether directly involved in the formal practice of Value Management or not, need to be aware of the concepts of Value most appropriate for their particular responsibilities and tasks:

- top managers should be aware of the notions and concepts behind Value Management and of the benefits it can bring, so that they can define a Value Policy and promote the appropriate style of management;
- some trained and experienced middle managers should understand how to set up and participate in Value Management programmes within their organizations in a way which is consistent with the Value Policy;
- all other members of the organization need to understand the methods in which they are likely to be involved and have a general awareness and understanding of what represents value in their organization;
- specialists (who may be members of the organization or external consultants) should have sufficient knowledge and experience in the use of appropriate methods and tools, and should be able to develop and train others in their use.

To create the conditions in which Value Management will flourish requires the introduction of a Value Management policy consistent with the organization's goals, the introduction and development of a value culture involving all categories of staff and the identification of a programme of activities to achieve results.

This may be achieved by setting up a framework which defines how and by whom the Value Management policy will be implemented, including training personnel in the appropriate knowledge and skills.

4.4 The Concept of Value

4.4.1 Value

According to the definition of Value given by EN 1325-1, Value may be described, in the context of VM, as the relationship between the satisfaction of need and the resources used in achieving that satisfaction (See Figure 2).

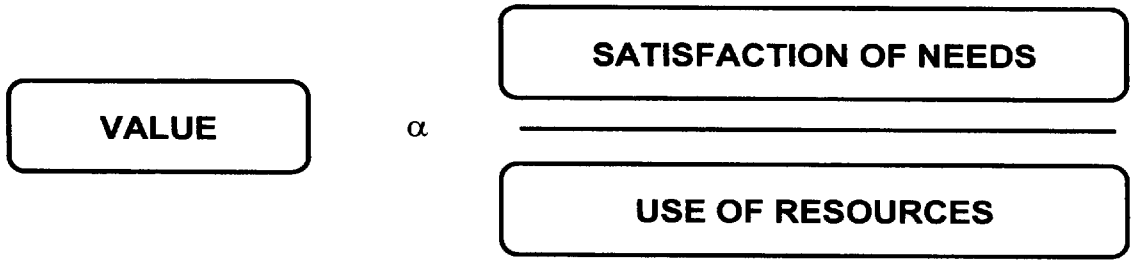

Figure 2 — The concept of value

NOTE: The symbol α signifies that the relationship between the satisfaction of need and the resources is only a representation. They are traded off one against the other in order to obtain the most beneficial balance.

Value is not absolute, but relative, and may be viewed differently by different parties in differing situations. Generally achieving good value requires balancing a series of conflicting parameters to arrive at an optimum position. For example, for external customers it represents the extent to which what is provided meets their expectations and the amount they have to pay to acquire and use the product or service. For the supplier, the fewer resources needed to satisfy the external customer, the better the value.

Within an organization, improved value may be represented by changing the way in which processes are carried out so that the same outcome is achieved within a shorter timescale or by using fewer resources.

To succeed in making real and objective improvements in value, it is necessary to have some basis by which Value is determined and to quantify, in some way, the top and bottom of the above relationship shown in Figure 2.

The optimization of Value is achieved by balancing the amount to which needs are satisfied against the resources utilized in so doing. It is important to realize that Value may be improved by increasing the *satisfaction of need even if* the resources used in doing so increase, provided that the satisfaction of need increases more than the increase in the use of resources (see Figure 3).

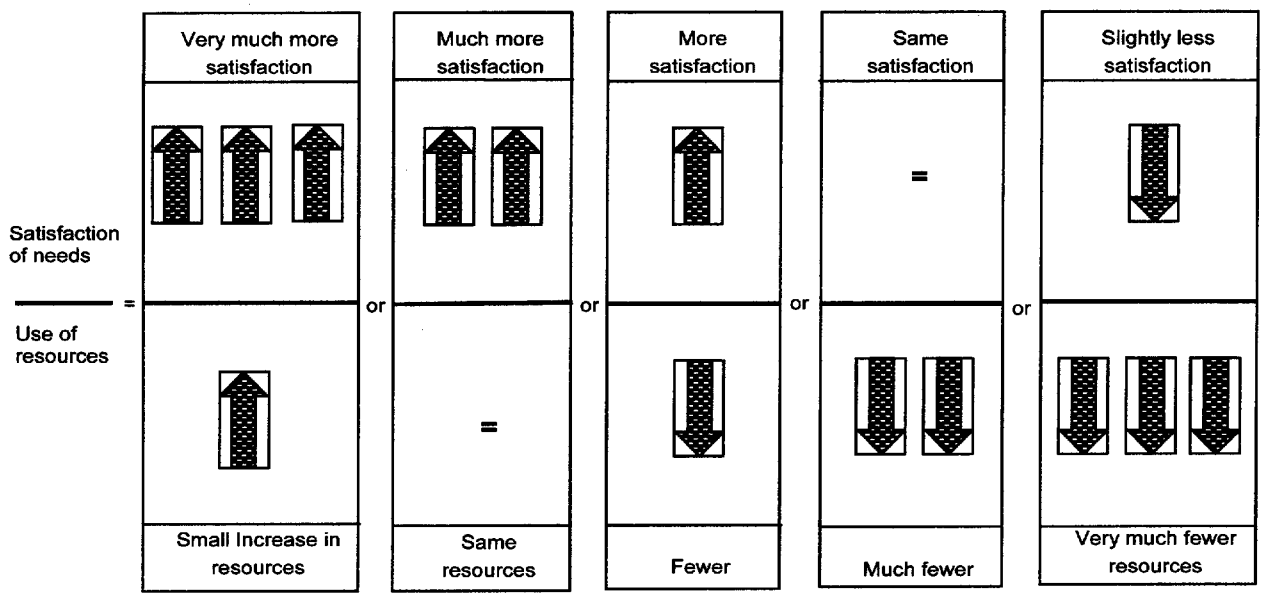

Figure 3 — Different ways of achieving equal value increases

For example a manager who wants to increase the output from his factory may add more plant or increase automation. Need is satisfied in both cases, but the overall resources used (initial cost plus operation costs plus other considerations such as influence on environment) may be less in the first or in the second solution, and consequently the value may be higher.

4.4.2 Need

As defined by EN 1325-1, need is what is necessary for or desired by the user. Management needs will differ for specific situations.

The total need generally comprises many different components. For example, use needs and esteem needs can be distinguished.

Use needs are the parts of the total need which refer to tangible measurable activities. For example, for a person who wants to eat a piece of meat, a knife should be able to make slices, and for the manager a factory should generate outputs. Similarly for the production manager, the purchasing department should have processes in place which allow the organization to buy raw materials and other items at the best price.

Esteem needs are the parts of the total need which are subjective, attractive or moral. Using the same examples as above, a knife may also need to be decorative or a factory provide the platform to impress customers and generate sales. The purchasing department should have attributes which encourage people to do business with them and retain the loyalty of staff.

The degree to which some of these needs are satisfied is easily measurable but others are less so. For instance, the units of measure of marketed goods and services is generally straightforward. However, for items which are not marketed, such as patient care in a hospital, other observations relating to the satisfaction of the need, such as the number of complaints, might need to be used as a measure. In these cases management methods such as cost-benefit analysis can be used to quantify non marketed needs.

Where satisfaction of a need cannot be quantified in monetary terms, it should be evaluated by the study team against an index using methods based on the opinion of a representative panel.

A need may arise, subsist, develop, and disappear due to reasons related with the person or entity, or to changes in the environment, the culture, or the technology available.

The need may be stated, implied or latent and the development of new products or services might trigger needs that have not yet been expressed.

Value Management should take into account all aspects of the needs for the organization, its customers and its owners.

Each of these needs is satisfied, in whole or in part, by the functions performed by the subject product or service.

4.4.3 Functions

According to the EN 1325-1 definition, a function is an effect of a product or of one of its constituents.

A need can be objectively described by certain functional requirements. The extent to which each of these functions is performed is assessed by the application of levels of evaluation criteria, preferably complemented by flexibility indications.

Those functional requirements concern what are called "user related functions" or URFs, and those attributes expected of a product, or performed by it, in order to meet a part of the need of a defined user.

URFs are enabled by functions internal to the product. Those internal functions are called "product related functions" or PRFs.

It is normal to express functions by use of an active verb and a measurable noun.

For good value regardless of the level of resource, the functions performed by the product should exactly match those required to satisfy the need as illustrated in Figure 4:

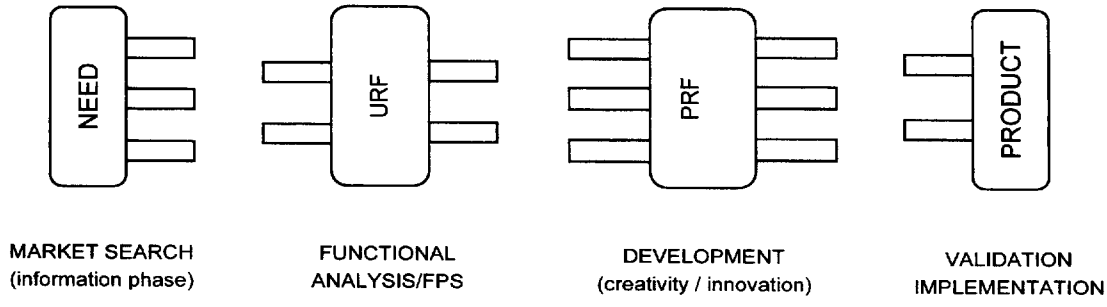

Figure 4 — Product performs functions to match the need

The abstract expression of functions (as distinct from the needs or solutions to satisfy those needs) is necessary to promote creativity and thus provide greater freedom for exploring innovative solutions.

Enhancements in value will be achieved by consideration of alternative ways to meet the required functionality.

4.4.4 Resources

Resources comprise everything that is required to satisfy the needs.

Resources will include not just cost (both long and short term) but also time, materials and other inputs, whether physical such as materials or abstract such as intellectual property.

The availability of resources is usually limited, with some resources being more critical than others. The availability of a resource may be of greater importance than its monetary cost. Generally all resources can be related to a cost.

In the development of a new product or service all resources likely to be needed for its development and production should be estimated. For an existing product, service or activity (such as management) the current use of resources can be measured and should form the basis from which improvements can be measured.

Recently the importance of time has increased because, for example, being first in the market place in itself often provides advantages.

4.4.5 Value comparison

Once the satisfaction of needs and the use of resources have been quantified (either in absolute or comparative terms), their ratio provides a measure of value which can be used for comparing one solution with another (See Figure 5).

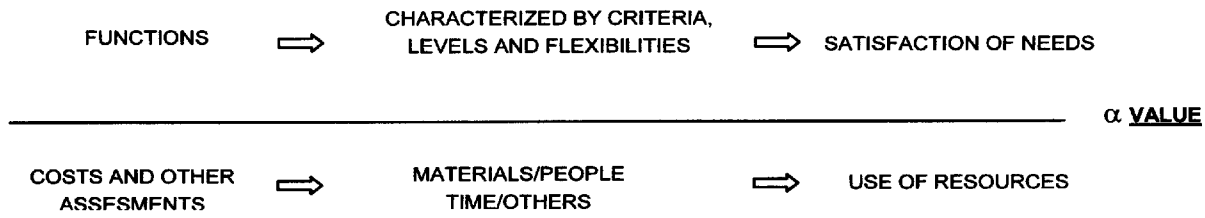

Figure 5 — The relationship between needs, functions and criteria, and resources

4.5 The Value Management Approach

The practice of Value Management requires that all levels of management adopt attitudes based on Value, which are appropriate to the organization to which they belong.

Value management is not simply the management of specific activities but a structured approach that requires that the following conditions be satisfied:

- commitment by the highest level of management to the concepts of value and function consistent with their goals (see key principles, 4.1);
- existence of a Value Policy consistent with the organization's goals;

- definition of objectives in terms of value;
- setting up of a Framework defining how and by whom the VM policy will be implemented;
- introduction and development of a Value Culture, involving all members of the organization, including training activities;
- recognition that management's responsibilities include two areas:
  - day-to-day management tasks in which they will apply the principles of Value Management intuitively;
  - specific management projects in which they will apply the methods of VM formally;
- determination of a programme of studies to which the methods will be applied to enhance value;
- feed back of results for continuous improvement.

5 The application of Value Management

Introduction

The previous clause described how the key principles of Value Management combine Management Style, Human Dynamics, Environmental Consideration and Methods and Tools. For these to be effectively and consistently applied, it is necessary to provide a management framework. This is described in the following clause and provides the essential link between the key principles and practical application and is illustrated diagrammatically in Figure 6.

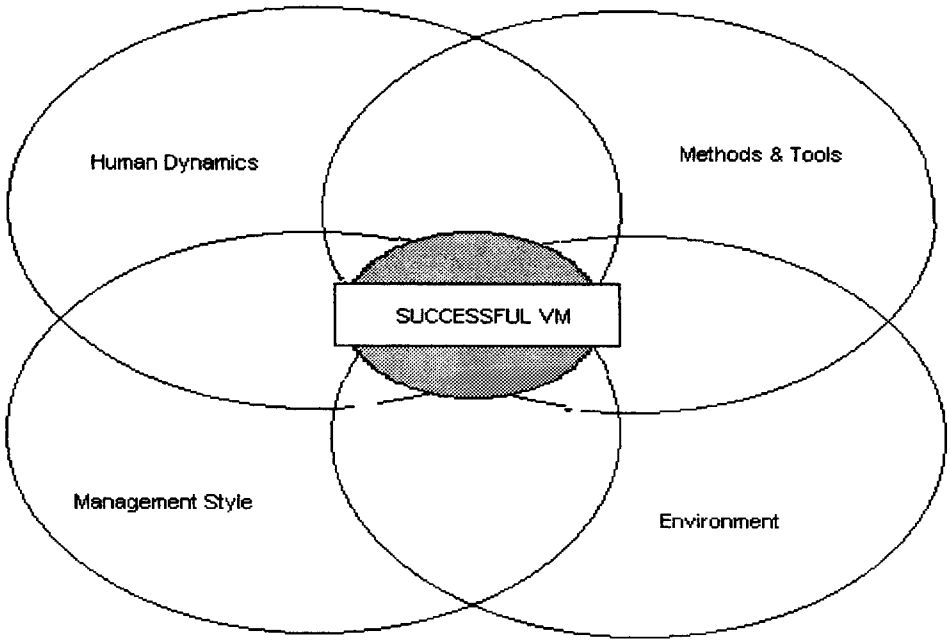

Figure 6 — Successful Value Management is provided by a framework which integrates Management Style, Environmental Considerations, Human Dynamics and Methods & Tools

5.1 Application of the principles

Management Style

- Application of the concept of Value.

  The value of an outcome is measured by the relationship between its effectiveness in achieving the objectives (or satisfaction of need) and targets, and the resources consumed.

  Management's aim is to achieve the greatest value for the different activities within their organization compatible with the satisfaction of the customers.

- Application of the concept of Function.

  Defining the desired outcome in a measurable manner or so that it can be assessed and setting targets before seeking the means of achieving it.

  Describing the outcome and the means of achieving it by the functions to be performed by the product or system, or by its subsystems, rather than by their physical characteristics.

- Creativity.

  Expressing the functions abstractly to enable creativity and innovative solutions.

  Encouraging creativity through positive human dynamics and the use of creative methods.

- Customer Focus.

  The focus of attention is on identifying and satisfying the real needs of the customer, both internal and external to the organization.

  The needs of all stakeholders should also be addressed.

- Quantitative Evaluation.

  Defining means of measurement or evaluation and setting quantified targets, in absolute or relative terms.

  Measuring outcomes and comparing with the targets as a means of objective evaluation.

Human Dynamics

In any organization its people are likely to be its most valuable resource. Making the best use of this resource is therefore vital. The people have the technical and managerial skills and the ability to communicate, but unless each of these is properly managed, people will not perform at their best.

In Value Management, the relationships and communications between people and emphasis on teamwork is paramount to achieve success.

Good communication is essential. Those involved in Value Management should be aware of and if necessary, trained in good communication. One of the greatest benefits of Value Management is the enhancement of communication between individuals in different parts of the organization or disciplines. This is achieved partly by encouraging good communication in the manner described above and partly by promoting good teamwork.

Team work requirements:

Team working is essential to achieve effective results.

To perform effectively, a good team should include each of the managerial and technical disciplines relevant to the task in hand. However, to be really productive, it is important to include a balanced mix of individuals, maintaining a reasonable size to the team, compatible with the efficacy of work. Every individual has a different but useful contribution to make to the team. To be successful, the team requires a leader, specialists and other members. A team made up only of specialists will not be as successful as that with a balanced mixture of characters.

To select the members of a team, the role to be played by each individual should be taken into account.

Value Management study leaders should be aware of methods of selecting team members, building teams and managing groups of people.

A well selected and trained team, communicating effectively will act with synergy, providing enhanced output and will readily accept ownership of outcomes which they may be responsible for implementing.

Environmental Considerations

The environment within which an organization exists shall be taken into account in any management action.

Value Management takes into account the broader environment, such as the organization's customers, suppliers' statutory and legal constraints, ecological considerations and it brings together various management methods so that they are used and applied when and where they are most effective.

Such pre-existing conditions may act as constraints whether imposed from outside the organization (for example national or international laws or public opinion) or from inside the organization (for example policy matters and culture). They may also take the form of opportunities, such as new legislation opening up new markets.

Examples of external environmental considerations include:

- laws and regulations, local, national or international;
- national and international customs, codes of practice, social and economic behaviour etc.;
- market conditions, competitors and suppliers;
- physical boundaries and infrastructure;
- limited availability of resources;
- ecological environment.

Examples of internal environmental considerations include:

- internal Policy and organizational rules;
- staff know-how and competence;
- culture of the organization and relationships between people;
- existing organization and processes for doing business;
- financial limits.

In either case the control of such opportunities or constraints is likely to fall outside the scope of Value Management studies but shall be taken into account.

Whereas middle managers are generally obliged to comply with environmental considerations, they should always be prepared to challenge the status quo since top management may be in a position to make exceptions to certain rules or bring about changes in policy matters or even legislation. Management should not take environmental constraints for granted.

Methods and Tools

Value Management methods fall into two classes:

- the method of undertaking a formal Value Management study - the VM study Plan;
- the methods (or techniques) used within a Value Management study.

The Value Management study Plan is described in Section 5.2 below and should be applied for all Value Management studies undertaken by the organization.

The methods most commonly used within VM studies are introduced in Section 6 below and described in more detail in the informative Annex A, where further methods are also listed.

5.2 The Value Management Framework

The interrelationship between the components of Value Management and the rest of an organization's management structure is indicated schematically in Figure 7.

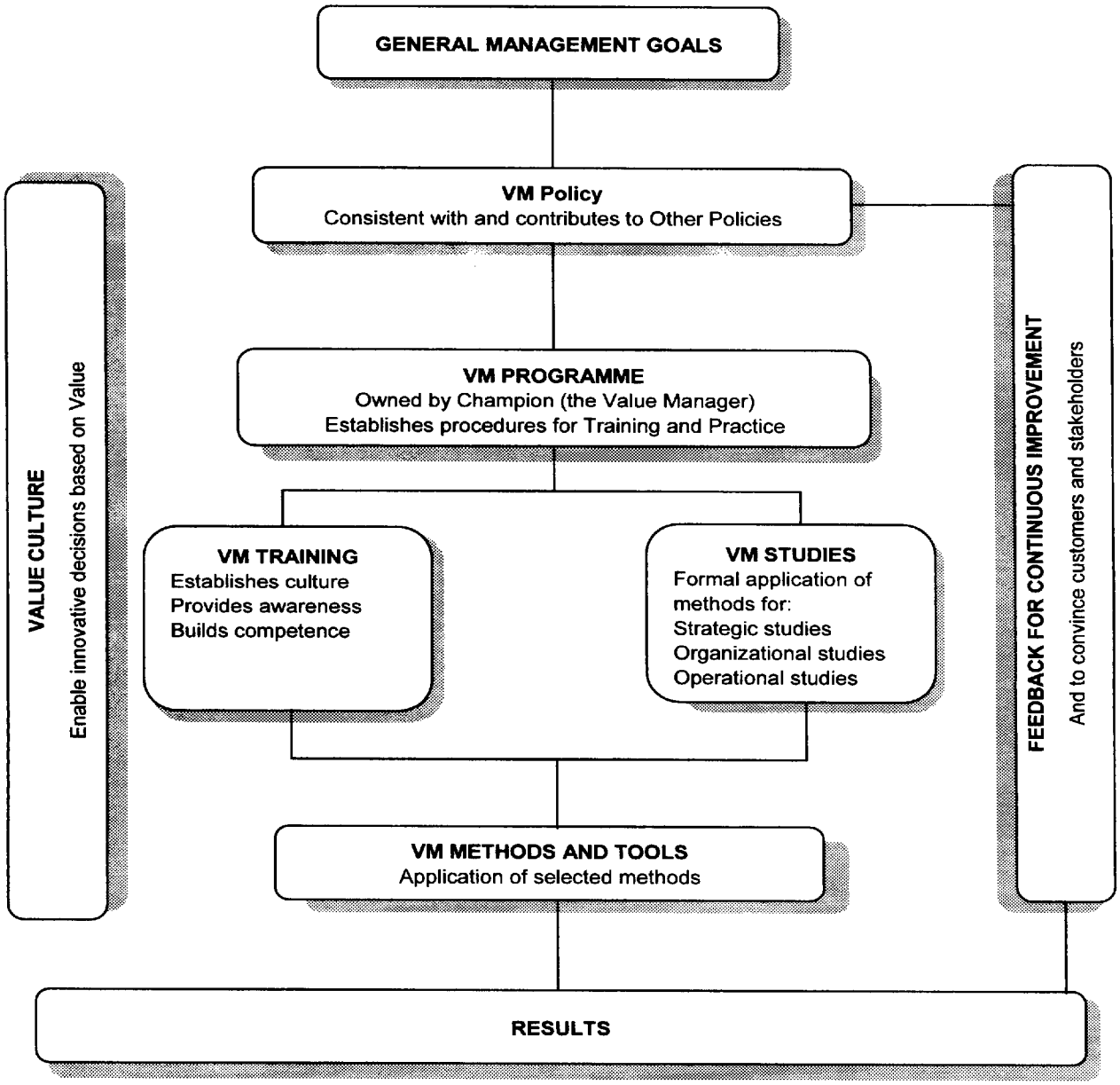

Figure 7 — Illustration of Value Management Framework within an Organization

Generally a Value Management study will be undertaken for relatively important or complex issues for which the investment entailed by the formal approach must be justified. The presence of a Value Management culture enables intuitive optimization of other issues.

Value Culture

The Value Culture should be present at all levels in the organization, whether actively involved in the VM process or not, and will be reflected in the organization's approach to doing business and how its members respond to challenges and opportunities presented to them.

The culture includes a common way of thinking and embrace an awareness of what Value represents for the whole organization.

The Value Culture includes an attitude, awareness and sufficient knowledge of what the concept of value represents for an organization, and involves making all members aware of the concepts, knowledge and tools and of the importance of value. This culture will vary from one organization to another but will be consistent throughout an organization.

In any organization with an established Value Culture, the main basis for decision making is value.

Value Management Policy

To practise Value Management, it will be necessary to introduce a Value Management Policy which will address all the aspects of Value Management in the Organization. This policy will be based upon the Organization's General Management Goals at the highest level since this will set the pattern for all other activities and objectives.

Top management shall adopt an outward looking policy to satisfy the expectations of stakeholders, external customers and, often, financial analysts. Middle management needs to focus on internal issues to deliver the outcomes to support top management. Both views shall be reflected in the Value Management Policy.

The appropriate Value Management Policy should be decided at top management level and be made the responsibility of a single manager or steering committee.

Value Management Programme and Organization

A Value Management Programme is a planned and structured array of activities which expresses the manner of implementation, development and maintenance of a sustainable Value Management Policy.

The task of designing, developing and implementing a Value Management Programme should be made the responsibility of a single individual, the Value Manager. The Value Manager reports directly to the highest levels of management and may chair a VM steering Committee. His duties will include:

- to collect and identify suitable subjects for VM studies;
- to define the scope of such studies;
- to estimate the target benefits;
- to form appropriate teams and identify team leaders;
- to organize training as necessary;
- to supervise progress of the studies and assist as necessary;
- to ensure that studies are conducted effectively by people with appropriate competencies.

In small and medium sized organizations, it should be recognized that one member of staff, or even the owner, may need to take on several of the roles which have been described above as applying to separate individuals in a large organization.

Necessarily the groups involved in undertaking Value Management studies may be smaller, but the same consideration regarding multidisciplinary teams and human dynamics should be applied.

This does not detract from the relevance of Value Management, but may result in a less formal approach in its application. To supplement their internal skills, such an organization may call upon the services of an external expert to conduct specific exercises or provide training.

The Value Management Programme will include:

- integration of Value Management within the organization and development of procedures;
- quantified targets, performance indicators and other means for assessing results;
- Value Management studies;
- appropriate resources, teams, timetables and budgets;
- a plan for appropriate deployment of resources;
- training and awareness for members of the organization;
- supporting non Value Management studies;
- a management plan of actions to be taken to implement the outcome of Value Management studies;
- mechanisms for feedback of results and continuous improvement (for example by a way of a procedures manual).

NOTE: Targets should be set for all the critical issues identified within a Value Management study. These targets may relate to more general management goals or they may be specific to the study. In either case they should be expressed in parameters which are measurable and they should provide yardsticks for measuring real improvements in performance, related to the management goals.

Value Management study

A Value Management study involves the application of one or more methods to a specific subject identified within a Value Management Programme. It will be led by a study leader and will have defined objectives.

The Value Management study will, regardless of the level at which the study is being undertaken, follow the sequence set out in Figure 8 below:

a) define the objective(s) of the Value Management study in relation to the Value Management Policy and Programme;

b) identify the methods and the supporting processes needed to achieve the objectives and select the teams (including application of training as necessary);

c) identify the functions which are essential to achieve the objectives and which together will result in the objective being attained;

d) identify how to measure changes in performance and use of resources;

e) set targets for performance and use of resources for each of the functions identified above in the most effective manner for the organization as a whole;

f) apply the methods and supporting processes to identify innovative ways of achieving the targets;

g) select and validate proposals for improvement;

h) implement the proposals which have been chosen by the decision maker;

i) monitor and measure the outcomes and compare with targets;

j) feed back results for continuous improvement of the Value Management Programme.

The above Value Management study plan supplements the work plans of the different Value Management disciplines. Points c), e), g), h) and i) in particular correspond to phases of these work plans. Point b) corresponds to the fact that a Value Management study often combines several Value Management disciplines and different supporting processes.

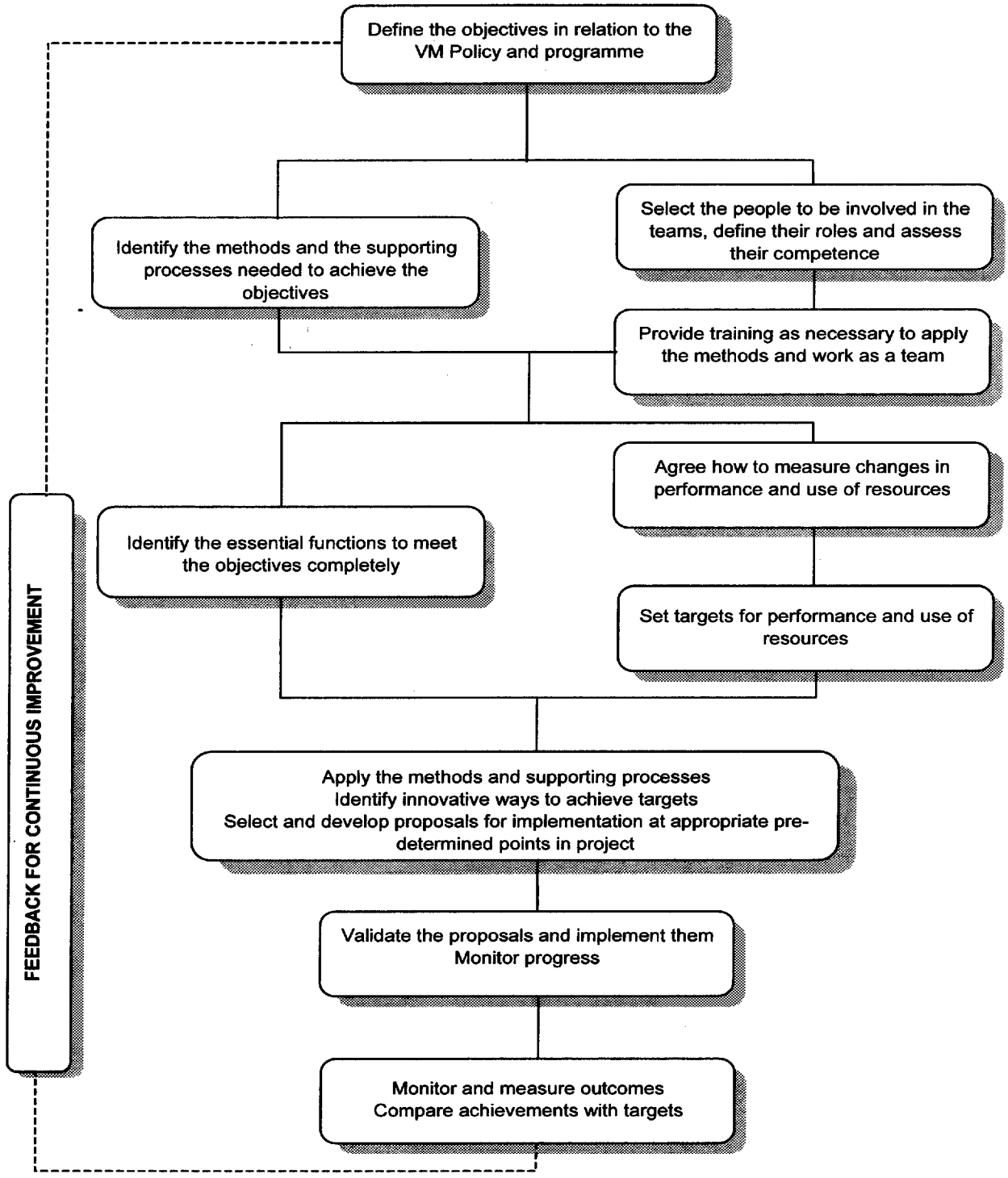

Figure 8 — The Value Management study plan

In addition to the other duties set out in Figure 8, the study leader should set a timetable for the study and identify the resources to be used. The timetable of the study should be consistent with available resources and related activities or events within or outside the organization.

A study may involve the use of one or more methods, chosen for their appropriateness to the study type rather than existing competencies within the organization and will include, in report form, recommendations for a plan for implementation of the results.

When a study and the implementation of its results is complete, the study leader should undertake an audit to ensure that all benefits have been implemented and to provide the basis of feedback for the benefits of future studies.

Value Management studies and other formal projects

The Value Management contributions to a formal project may be continuous or focused to address issues requiring particular attention. Often they will coincide with specific project milestones in order to assist the project management team progress from one phase of the project to the next.

The relationship between the Value Management contribution and typical Project Management activities is illustrated in Figure 9 below.

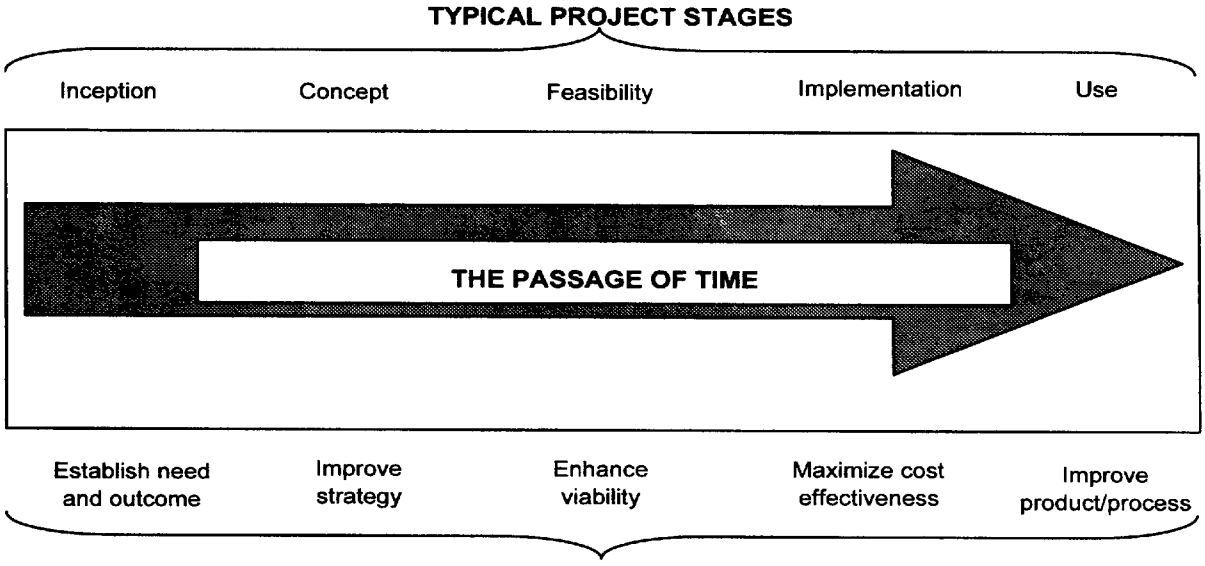

Figure 9 — Interaction of Value Management with Project Management

Most projects pass through similar evolutionary stages from inception to completion. The coordination of Value Management activities throughout the project improves confidence that one stage is sufficiently complete and that conditions are right to progress to the next stage.

Value Management Training

Before an organization can embark on a Value Management Programme or specific Value Management studies, it will be necessary to ensure that adequate competence exists within the organization (unless such expertise is brought in from outside). Training is necessary not only to develop the Value Culture in the organization but also to develop competence in the management and skills to be used within a Value Management Programme.

This requires identifying the levels of competence in each of the methods to be applied across the organization and then applying appropriate levels of training.

Training will specifically be required in the following areas:

- for Senior Managers to enable support for Value Management activities;
- for Value Management study leaders and team leaders who will need to apply the methods;
- for team members to enable effective participation in the studies;
- for other staff to enable them to provide information to the studies and to develop an awareness of value.

When first trained in Value Management methods, individuals at operational level should recognize the limits of their competence and address relatively straightforward issues. As the Value Management Culture matures and those involved accrue experience (backed by appropriate training), so the more experienced individuals may apply the processes to more complex and strategic issues.

The application of a method of assessing and recognizing individual competencies will avoid exposing inexperienced individuals to challenges which exceed their competence levels.

6 Value Management methods and tools

6.1 A selection of methods commonly used in Value Management

Several different Value methods and tools, many of which are related, have been developed over the years. We call these the specific Value methods and tools.

Currently these include Value Analysis, Functional Analysis, Function Cost, Functional Performance Specification, Design to Cost / Design to Objectives.

Each of the following sub-sections outlines one of these methods or tools and its use within Value Management. Detailed descriptions are given in the informative Annex A.

There are other methods and tools that may be used concurrently with the specific methods (for example Creativity, Failure Mode Effects and Criticity Analysis, Life Cycle Cost, Quality Function Deployment, and many others). Some of these are also listed in the informative Annex A.

All of the available methods shall be considered for use in any given study; they should be combined to create the most suitable approach to the proposed study.

6.2 Specific Value methods and tools

6.2.1 Value Analysis (VA)

6.2.1.1 Presentation

Value Analysis is the basis from which Value Management has developed. Today VA is a powerful and most frequently used method to undertake VM studies.

It is defined as an organized and creative approach, using a functional and economic design process which aims at increasing the value of a VA subject.

The use of VA makes organizations more efficient by improving the competitiveness of their products. This improvement is obtained by an approach applied to the product that makes it possible for the producer and the user to design, produce, maintain and use it effectively.

6.2.1.2 Value Analysis and Value Management

Together with other techniques which help to establish value, VA is one of the specific VM methods. VA can be considered to be for tactical use, i.e. applicable to definite projects and used concurrently with other VM methods such as Functional Performance Specification (FPS) or Design to Cost/Design to Objectives (DTC/DTO).

6.2.2 Functional Analysis (FA)

6.2.2.1 Presentation

Following EN 1325-1, a function expresses the effect of a product or of one of its constituents and is accompanied by performance indications (levels and flexibilities). This simple concept provides Functional Analysis with an important added value.

FA involves identifying functions, validating them with the help of clear logical elements and characterizing them. This approach enhances communication to obtain a common understanding between the team members as to the project fundamentals.

FA is used:

- to identify the functions of a product, a system or an organization;
- to quantify the performances to be reached;
- to act as a means of improved communication between those involved in the definition, the design and the development of the product.

FA requires those involved in the study to abstract themselves from solutions and to think in terms of objectives and end results. Viewing the problem in the abstract removes constraints and encourages creativity.

Describing the product's functions facilitates a common language and enables thorough comparison between needs and products.

The term user shall not be limited to the end user alone, even if the latter is often the principal user of the product. We shall identify and consider as users all those who, for each of the phases of the product's life cycle, have particular requirements or expectations with regard to the product.

FA is a process that results in a comprehensive description of the functions and their relationships, which may be systematically characterized, classified and evaluated. The function model is the result of Functional Analysis (see EN 1325-1). It may be represented by diagrams which provide a common understanding by the working group of the functional performance.

6.2.2.2 Functional Analysis and Value Management

FA is an essential component for quantifying value and is therefore at the heart of the VM approach, at any strategic or technical level.

The kind of FA and the kind of functions that are worked on may change during the progress of study, beginning with the formalization of the marketing objectives and ending with the validation of a proposal, which ensures that the reliability and safety necessary for the fulfilment of the objectives will be met.

Furthermore, formal FA should be performed by other disciplines and this gives an opportunity to combine approaches and methods of complementary fields such as safety and reliability.

FA, naturally both creative and rational, strongly contributes to the evolution of the culture in the enterprise, helping it on the way to VM.

6.2.3 Function Cost (FC)

6.2.3.1 Presentation

Costs calculated by conventional procedures are usually expressed on an elemental basis. Reallocating costs to the functions of a product provides new insights to the way we consider that product.

A function cost is the total of the expenditure (use of resources) predicted or incurred in providing a function in a product. The sum of the costs of providing all the different functions equals the total cost of the product. Determining function costs is part of the FA process.

NOTE: This section only refers to initial costs. Whereas the life cycle cost of the whole of a product is often to be considered, those of isolated functions can rarely be significant and are not usually considered.

6.2.3.2 Function Cost and Value Management

We often need to know the value of individual functions (for instance for marketing decisions) as distinct from the value of the products or services as a whole. FC provides the "link" between the product features expressed in terms of function(ality) and the related cost. Consideration of the cost of functions (instead of elemental costs) is a powerful method within the VM approach.

In many cases, it is only possible to define value in accordance with the description outlined above in relative figures. Even if reliable and absolute figures are difficult to obtain, the construction of the function costs is very beneficial. The benefit is not in the calculation of precise figures, but the insight gained by thinking about the value of a product as a whole and about the value of each of its attributes.

FC provides deeper insight of how the value of a product is constituted. It requires critical, objective discussions and because each cost element shall be related to at least one function, it explains the reason for its existence.

6.2.4 The Functional Performance Specification (FPS)

6.2.4.1 Presentation

A Functional Performance Specification is a document by which an enquirer expresses their needs (or those which they are responsible for expressing) in terms of user-related functions and constraints. For each of these, evaluation criteria are defined together with their levels, with a certain degree of flexibility being assigned to each one.

The expression of these user's needs in the FPS is made in functional terms without reference to the technical solutions that may satisfy them and with a minimum of constraints.

This allows the enquirer to obtain from the designer, manufacturer or supplier the design, the realization or the proposal for the most efficient product, that will be the most advantageous for the user.

To achieve this, it is necessary that every opportunity should be explored and that the terms of the FPS should stimulate the designer, manufacturer or supplier to optimize the product or to find the best proposal. This implies that the possible flexibilities should be indicated. It encourages constructive dialogue between a client and a supplier or contractor.

The FPS encourages the examination and the comparison of different proposals on a functional basis, the framework of which is given by the FPS and used in the supplier's response.

6.2.4.2 The Functional Performance Specification and Value Management

FPS can be used for any product, service or process.

The enquirer can be the direct user of the product, or the Marketing Department of a company that will sell it. The enquirer can be a buyer who has to acquire the product for a user, or they can be the designer who has to integrate the product as a component or sub system into the system they are developing.

FPS may be used either in the relationship between a client and a supplier or, inside an enterprise, between a department that asks for a product (for example a production tool or a service such as a particular accounting study) and the department that is going to both design and deliver it.

6.2.5 Design to Cost (DTC)/Design to Objectives (DTO)

6.2.5.1 Presentation

Design to Cost is an anticipative managing method which, from the start of the development programme of a product or system, takes the production costs into account. It does so until the end of development, when industrial costs consistent with the goals that were aimed at are obtained.

The anticipated production cost is considered as a performance that must be attained, as well as the technical performances, which can even be reduced if necessary. During development, a balance between cost, performance and schedule will be a permanent and continuously assessed concern.

DTC makes it indispensable to have a management procedure which is supported by a continuous exchange of information and coordinated actions between customer and contractor, or between contractor and sub-contractors. From the start of a programme onwards, it requires organization, procedure trade-off rules, and cost estimating tools.

DTC requires a plan that describes all the tasks, from the beginning to the end of the programme.

Design to Cost (DTC) evolves into Design to Objectives (DTO) when objectives other than costs are considered.

NOTE 1: DTC monitors the trade-offs between cost, performance and schedule, these being attained through the best available tools. This leads to emphasizing the importance of Value Analysis for a DTC management of a project, although VA and DTC are distinct methods. DTC does not imply that VA should compulsory be used.

NOTE 2: On the contrary, Functional Analysis is one of the steps of the DTC process. This highlights the relationships between VM methods and tools.

6.2.5.2 Design to Cost and Value Management

DTC appeared several years after VA and FA. Up until then, to some extent, VM methods had been used to maximize Value without profoundly questioning the functions and performances that were considered as expressing the need, once they had been carefully determined.

DTC brought a new dimension for the management of organizations.

Annex A
(informative)

Methods and tools to be used within Value Management

- Specific Value Methods and tools

- Other methods and tools

A.1 Specific Value methods and tools

In order to make this annex a self-sustaining document, the presentation chapters of clause 6 of EN 12973 are given at the beginning of the sections beneath.

A.1.1 Value Analysis (VA)

A.1.1.1 Presentation

Value Analysis is the basis from which Value Management has developed. Today VA is a powerful and most frequently used method to undertake Value Management studies.

It is defined as an organized and creative approach, using a functional and economic design process which aims at increasing the value of a VA subject.

The use of VA makes organizations more efficient by improving the competitiveness of their products. This improvement is obtained by an approach applied to the product that makes it possible for the producer and the user to design, produce, maintain and use it effectively.

A.1.1.2 Detailed description

(1) Characteristics

(a) General considerations
VA helps formulate problems correctly and solve them.

The method applies to the design of products in order:

- to provide the services which the customers and users request;
- to optimize the use of the resources of the organization and/or of the users.

(b) Fundamental Elements of VA
It has been explained in 4.1 that VM brings together:

- management style;
- human dynamics;
- consideration of internal and external environmental factors;
- methods and tools.

To be successful, all VA activities and projects have to be managed according to certain principles, which define responsibilities of **management** within the VM structure of an organization.

In any VA action **human factors** are important. This human element embraces, among others, factors like team membership requirements, team leadership and personal behaviour requirements.

A special consideration has to be given to the **environment** in which VA studies are carried out. In particular, the effects of and the effects on the organization, its customers and suppliers, of statutory and legal constraints as well as ecological requirements have to be taken into account.

(c) The methodology of VA
The VA methodology is characterized by:

- a **functional approach** that requires the problem to be formulated in terms of end results and not in terms of solutions; it establishes what is essential and relevant, and thus avoids the tendency of participants to limit themselves to existing solutions and to unconsciously exclude possibilities;

- the functional approach requires the use of formal **Functional Analysis** (FA) (see A.1.2):

  - to clearly define the need through the identification and formulation of user-related functions, the description of which includes their level of performance (URF's, see A.1.2.2);
  - to organize the creative phase; it deals first with the architecture of the product and then its detailed development, using for the latter product related functions (PRF's, see A.1.2.2) to support the working group's train of thought;
  - to carry out a critical review of existing solutions and techniques, eliminating or reducing the possible unnecessary or undesirable functions;

- an **economic approach** which takes into account the economic aspects of issues by systematic reference to costs and value criteria, both of previous products of similar type (and to their functions), and those that can be estimated for each function or each alternative solution;

- a **multidisciplinary team approach**, the notable features of which are:

  - it promotes the solving of problems that, otherwise, would be tackled only successively and separately by different people who play a part in the creation and realization of the product;
  - the team brings together the required multidisciplinary skills and persons with different training and responsibilities;
  - thus the team-work makes it possible to arrive at a consensus on functions, performance, principles, solutions and costs;
  - team-work favours the exercise of creativity and improves and increases the available information;
  - in particular, the team shall include members who have the necessary expertise for cost estimation on the basis of the information available at each stage;
  - the team makes proposals, but the acceptance remains that of the decision-maker;

- a **creative approach** which aims at increasing the variety of solutions to consider and takes into account the market, the environment and technical change;

- a **systematic, organized and participative approach**, using a typical work plan which is explained in (2).

Notable features of VA work are:

- a critical analysis of data, information and solutions before they are taken into account;
- its typically iterative process;
- the specific use of techniques and tools, among them functional analysis and value thinking;
- the motivation for those who use VA.

(2) Implementation

(a) VA work plan
The main part of the method element is the VA work plan (table A.1) which describes a process in nine phases (plus a preliminary phase) and is a synthesis of the approach that proved efficient in practice. It provides a good understanding between team members and a good follow-up to the analysis being carried out. In practice, the implementation takes into account the many different situations.

Hereafter, in order to be easily understood, the VA work plan is described for industrial enterprises. Moreover, it is described following a sequential process, whereas in fact its real application is iterative: each phase can be considered again in the light of the phases that have followed it. Similarly, overlaps between some phases can be desirable.

(b) Organization
The matrix (see table A.2) shows the division of responsibility and participation for each phase of the VA work plan.

(3) Uses and applications

VA originated in the United States around 1947 and was first applied to redesign existing products. It has rapidly been put into practice for new product development. Areas of application have widened to include non-material subjects such as administrative procedures or organization systems.

The widening of the field of application of VA, the expansion of VA techniques, particularly the application of functional analysis and the value concept in management practices, has given birth to VM, of which it is one of its core techniques.

Table A.1— Value Analysis work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
0 Preliminary phases	0.1 Project outline		
	0.2 Feasibility investigation, risk analysis	These are high level and short studies	Cost-estimating models (for development, for production)
	0.3 Profitability investigation, what is at stake		
	0.4 Decision-maker and VA project leader selection		* Definition of VA project leader requirements
1 Project definition	1.1 The subject		
	1.2 Framework of the study	Coherence with the organization strategy Laws, regulations Constraints Scope and limits of the study	
	1.3 Premises of the data about problem	Needs to be satisfied Market Competition	
	1.4 Marketing objectives	Position relative to competition (price, performances attained, advantage over competition)	
	1.5 General objectives	Cost or cost reduction (development, production) Dependability (reliability, safety, maintainability, availability) Return on investment rules for decisions and selections Allowance of time	
	1.6 What is at stake	From a strategic and economic point of view	
	1.7 Resources	Manpower, equipment	

continued

Table A.1 (*continued*)— Value Analysis work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
	1.8 Participants	Fundamental guidelines and general instructions only (this matter has to be considered in de-tail when constituting the working team)	
	1.9 Preliminary risk analysis	The risks brought about by the project, those brought about by the product	
2 Planning	2.1 Constituting a working team	According to the problem, the team may also be created during phases 3 and 4	* Rules applying to the composition of VA teams
	2.2 Working out an initial time schedule		
	2.3 Agreeing venue for work		
3 Gathering comprehensive data about the study	3.1 Information gathering (internal, and external): - technical information (about the product); - economic - about competition; - state of art (technology).	Typical sources: - After-sales; - Gathering of field experience; - Technical manual.	
	3.2 Detailed market survey: - customer requirements; - the market; - determination of the position of the product to be developed.	Comparative to competition (internal and external)	
	3.3 Miscellaneous: - bibliography; - patents; - laws and regulations, standards; - organization's rules, manuals, standards, etc.	As a source of information, of constraints	

continued

Table A.1 (*continued*)— Value Analysis work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
4 Functional analysis, cost analysis, detailed objectives	4.1 Expression of need and functional analysis	Structuring and hierarchical ordering of functions, establishment of the function structure Functions characterization Key functions compared to competition	* Functional analysis techniques * Organizing the functions (trees, FAST diagrams) * Functional Performance Specification (see Section A.1.4) * Evaluation criteria, their levels, cost variation claimed or accepted for a variation in a level * Techniques for the establishment of function costs Dependability studies (and among them: need FMECA, risk analysis)
	4.2 Cost analysis and function cost		
	4.3 Fixing detailed objectives and evaluation criteria	Within the global objectives set by Management	
5 Gathering and creation of solution ideas	5.1 Gathering of existing ideas		
	5.2 Creation of new ideas	Successive consideration of: - a global arrangement of proposals; - more detailed solutions for the concepts that are being contemplated	Creativity techniques Organization of PRFs
	5.3 Critical analysis	Search for possible useless or undesirable functions	

continued

Table A.1 (*continued*)— Value Analysis work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
6 Evaluation of solution ideas	6.1 Evaluation of ideas, combining them		Cost estimating models
	6.2 Choice of what is to be developed		
	6.3 Work programmes for development		
7 Development of global proposals	7.1 Studies, tests, industrial development	This is within the scope of the regular activities of the organization	
	7.2 Follow-up, coordination		
	7.3 Evaluation of the solutions: - qualitatively; - economically; - risk analysis.	Considering the functions and the levels obtained for the different evaluation criteria (see 6.2.4)	
8 Presentation of proposals	8.1 Selection of the solutions to be proposed		
	8.2 Working out of implementation programmes		
	8.3 Organizing comprehensive data about the proposal		
	8.4 Obtaining a decision from the decision-maker		
	8.5 Keeping the VA team informed and either dismissing or putting it on stand-by		
9 Implementation	9.1 Support of the implementation: - follow -up; - possible assistance to correct deviations, or for adaptations.	The operative departments of the company are normally in charge of the implementation itself	
	9.2 On exceptional occasions, organization of other meetings of the VA team to tackle an unexpected problem (reactivation)		

continued

Table A.1 (*concluded*) — Value Analysis work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
	9.3 Assessing the actual results of the implementation, comparing them with the prospective results	Or participation in the establishment of this assessment (prospective results were evaluated in elementary steps 0.3 and 7.3)	
	9.4 Disseminating the assessment of the actual results and the technical and general information: - to the VA team members; - to the experts concerned; - more widely in the organization.	Particularly for motivation purposes	
	9.5 Perhaps establishment of a system to collect information about field experience		

Table A.2 — Responsibility (●) and participation (X) during the phases of the VA work plan [1)]

Phase Name	Phase Nr.	Decision maker	Team leader or VA project leader	Working group	Operational departments
Preliminary Phase	0	●			X
Project Definition	1	●	X		X
Planning	2		●		
Gathering data	3		●	X	X
Functional Analysis	4		●	●	X
Gathering Ideas	5		●	●	X
Evaluation of solutions	6		X	X	●
Development of proposals	7		●	●	X
Presentation of proposals	8	●	●	●	X
Implementation	9	●	X		●

1) The responsibility and participation will vary from project to project and from organization to organization.

A.1.2 Functional Analysis (FA)

A.1.2.1 Presentation

Following EN 1325-1, a function expresses the effect of a product or of one of its constituents and is accompanied by performance indications (levels and flexibilities). This simple concept provides Functional Analysis with an important added value.

FA involves identifying functions, validating them with the help of clear logical elements and characterizing them. This approach enhances communication to obtain a common understanding between the team members as to the project fundamentals.

FA is used:

- to identify the functions of a product, a system or an organization;
- to quantify the performances to be reached;
- to act as a means of improved communication between those involved in the definition, the design and the development of the product.

FA requires those involved in the study to abstract themselves from solutions and to think in terms of objectives and end results. Viewing the problem in the abstract removes constraints and encourages creativity.

Describing the product's functions facilitates a common language and enables thorough comparison between needs and products.

The term user shall not be limited to the end user alone, even if the latter is often the principal user of the product. We shall identify and consider as users all those who, for each of the phases of the product's life cycle, have particular requirements or expectations with regard to the product.

FA is a process that results in a comprehensive description of the functions and their relationships, which may be systematically characterized, classified and evaluated. The function Model is the result of Functional Analysis (see EN 1325-1). It may be represented by diagrams which provide a common understanding by the working group of the functional performance.

A.1.2.2 Detailed description

(1) Functions

The end purposes, i.e. the functions, of the VM subject are considered instead of the solutions that are usually chosen or that may be envisaged to be generated.

FA is the principal VM tool to investigate the VM subject's functions, to structure and characterize them and to set cost objectives for them.

It should be recalled that there are two types of functions:

- **User-Related Function** (URF) (or "service function" or "external function") that describes what the product does or has to do to satisfy the needs and desires of the users during its whole life cycle: the **WHAT FOR ?**

- **Product-Related Function** (PRF) (or "technical function" or "internal function") that describes the internal actions of the product to work out the answers to the need, these answers being URFs or service functions.

  The PRFs can be the formalization of the principles or physical phenomena used and of the solution structure which is being considered or developed. They also allow an analysis of the way the product operates, in order to improve the understanding of the solution or to allow the performance of the product to be fully tested and verified. It is the formalization of the **HOW ?**

Let us first consider URFs which are effects of the product on the user or on elements that surround him, these functions being aimed at satisfying the user's needs.

Within this type of function, and considering the functions actually performed by an existing product, some may result from slightly imprecise appreciation of the need, or of an unexpected and adverse effect of the product which has actually been generated. These functions may be called, respectively, unnecessary functions and undesirable functions.

The PRF's are a completely different type of function and play no direct part in satisfying the user's need, but they are present to ensure that the product works and finally performs the URF's. These PRF's, which the user is usually unaware of, are actions of the components of the product. These components can either work independently (i.e. an electronic component will store information) or in conjunction with other components (on a car, the shaft transmits torque from the gearbox to the wheel).

(2) General description of the FA process

To implement FA implies working through a multidisciplinary team. All the professionals within the organization concerned directly or indirectly with the product at each stage of its life cycle will be called upon to participate.

FA is normally implemented by a working group selected for its necessary skills and experience in finding the functions and formalizing the result of the Functional Analysis.

This way of thinking and of formulating things in terms of functions focuses on need and is a powerful means of inducing order and clarification. It is essential to the control of complex systems and it brings about synergy. It supports quality and improves the dialogue within the VM team as well as between client and supplier.

FA is a process which makes it successively possible to:

- identify and list;
- organize;
- characterize;
- put in a hierarchical order; and
- evaluate

functions.

In the following pages, the steps of the FA process are described in detail:

Step 1: Identifying and listing the functions.

The objective of the process is a complete description of the end purpose of the product.

To end up with a clear description, it is necessary systematically to take care of the formalization of each function and check that it correctly expresses the objective.

The description shall be clear and brief, with a **verb** specifying the nature of the action required to satisfy the need, and a **noun** indicating the element on which an action is exerted.

The first phase has to be absolutely exhaustive even at the risk of proliferation and redundancy in the listing of functions.

Step 2: Organizing the functions.

The objective of the second phase is to arrive at a clear, organized list of the functions to be taken into consideration and to present them in a **logical arrangement**. It can have the form of:

- a table (functions, criteria, constraints);
- a functional tree;
- a model; etc.

One has to be careful about being consistent in the organization of the description.

All functions, when organized and structured, shall give a complete qualitative description of the need under consideration.

For user-related functions, FA establishes the need to be satisfied, for product-related functions FA allows to provide answers to the need.

Step 3: Characterizing the functions.

The analysis, which so far has been of a qualitative nature, will during this phase be supplemented by the quantification of the expected **performances** of the different functions.

It makes it possible:

- to describe the performance assessment methods;
- to indicate the performance objective levels, taking into account the desires or needs of future users;
- to specify whether the service desired is absolutely necessary or whether it can be slightly varied;
- to come up with the initial information for making a study of the risks linked to the use of this product;
- to indicate as often as possible the possibility of varying the performance levels through what is called their flexibility; the latter can be expressed by:
  - classes of flexibility; or
  - exchange rates (cost/benefit ratios for instance);
- to define the acceptable range for these levels, which limits the possibility of variation;
- to provide information about possible failure, indicating how serious it is in relation to the kind of risk to which the user is exposed.

Thus, the purpose or objective to be reached is completely described.

Step 4: Setting the functions in a hierarchical order.

The setting in a hierarchical order of user-related functions consists in assigning an **order of importance** to them, reflecting the viewpoint of the users generally.

It shall be ensured that this hierarchical order reflects the expectations of the market and the users, and not the mere feelings of the working group.

Step 5: Evaluating the functions.

The evaluation of the functions consists in attributing to them a "weight", constituting a sort of quantification of the hierarchical order.

This phase shall not be confused with the definition of the function costs. The latter is necessary to appreciate the appropriateness of a solution and therefore the value of the product, but the idea here is different.

Putting in a hierarchical order and evaluating the functions are necessary in order to specify the **expectations of the users** which should be taken into account throughout the product design.

Functions organized and described in this manner will be presented in the way best suited to the use made of them later during the progress of the project. This can be considered as the function structure of the product.

(3) Usual FA techniques

Different methods are used for the various phases of the overall process of FA, from the listing to the evaluation of functions. We examine below the methods which are most frequently used:

- the natural or intuitive search;
- the method of interaction with the external environment;
- FAST;
- other FA techniques such as the Structured Analysis methods (SA, SADT, SA-RT).

(a) Natural or intuitive search
This method is more appropriate when there is an existing product.

The **main steps** of the technique are:

- **Step 1**: Identification of current functions by considering existing systems, other systems which have the same end results, or alternatively the proposals that are currently available;
- **Step 2**: Search for anticipated functions by logical analysis of the need;
- **Step 3**: Critical examination of the current or envisaged functions: are these functions beneficial or necessary with regard to the project ? For secondary functions, the answer will depend on the cost incurred by their realization;

  This critical examination will highlight the useless or undesirable functions that may be provided by the product:

- **Step 4**: Enrichment of current or envisaged functions: it may be useful for the product to perform some functions which are not yet provided by existing products or that were not envisaged at a previous stage; these functions, which may provide competitive advantage, can be found by:

  - review of the logic of utilization.

    It is necessary to consider the different phases of the use of the product, thus often revealing neglected secondary needs:
  - examination of the cases of dissatisfaction.

    Such an examination sometimes reveals secondary functions that are not being performed by the product and helps to detect those current functions where the level of performance is insufficient:
  - creative thinking.

    Interesting ideas will perhaps be found.

(b) Method of interaction with the external environment
In this method, for each significant step in the life cycle, the anticipated effects of the product and its reactions relative to its external environment are established. Each element of the external environment considered constitutes what is called an interactive agent. Sometimes the expression "determining element" of the system to be developed is used. Determining elements can be of different kinds (see Figure A.1):

- people operating the product;
- constituent elements of the external environment;
- the other systems or subsystems interfacing with the product; etc.

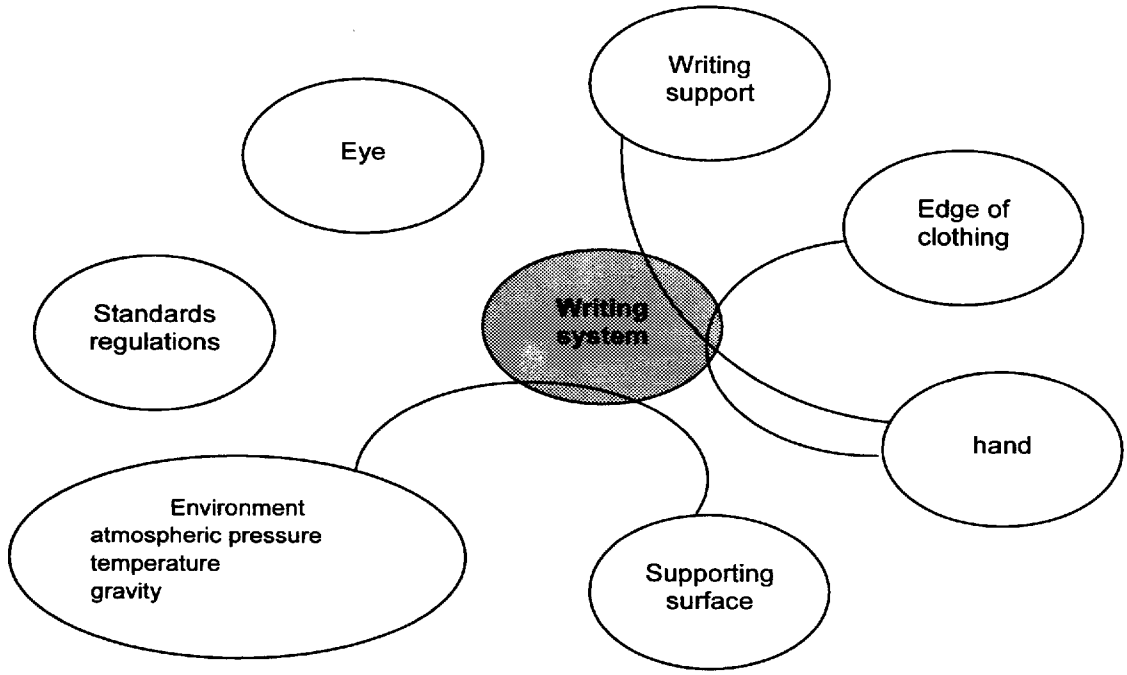

Figure A.1 — Determining elements, search for the functions

The **successive steps** of the method are:

- **Step 1**: Identify the different interactive agents which, as a whole, constitute the operational environment of the product;
- **Step 2**: Briefly describe each of them, particularly by specifying their expectations and interactions with regard to the product;
- **Step 3**: Consider the relationships between interactive agents via the product. Each time an action of the product participates in this relationship a function has to be identified;
- **Step 4**: Consider the determining elements in relation to each other, which reveals most of the functions. Some concern more than two elements, but these functions are normally found as soon as two elements are associated; some functions may concern only one element;
- **Step 5**: Consider the relationships between the product and one given interactive agent alone. Finally, each of these relationships will be systematically examined to identify:
  - either particular functions of the product relative to a given agent;
  - or particular actions on the product by a given interactive agent to which the product will have to respond.

NOTE 1:The FA approach allows one to identify both the functions and the constraints that the system which is to be developed will have to meet.

NOTE 2:In practice, intuitive research is the first choice. With little effort, most of the functions are found and organized almost naturally. Besides, it is quite difficult to tackle a complex system directly using determining elements. But after using the intuitive method, it is indispensable to complete the functional analysis using determining elements: this leads to the alteration of a few function formulations and generally some functions or complementary constraints appear.

(c) The FAST diagram
FAST (Function Analysis System Technique) was designed by Charles W. BYTHEWAY in 1963.

FAST, sometimes called a logical functional diagram, is a presentation of the user-related functions and product-related functions of a solution for a product (whether existing or in the process of being developed).

The power in the FAST approach, perhaps more than the diagram itself, lies largely in the mastery of the subject that is attained by the members of the working group. At the same time, the doubts, remarks, questions that accompany the construction of the diagram favour creative thinking.

A FAST diagram (see Figure A.2) is limited by two vertical lines that delimit the scope of the problem, and on the left of the left line is to be found the "higher level" function, which is in fact the general need.

One moves in the diagram **from one function to another:**

- from left to right by asking the question: **HOW ?**
- from right to left by asking the question: **WHY ?**
- in addition, functions that happen at the same time as another function or that happen all the time may be placed vertically.

Functions identified by intuitive and logical thinking are placed to constitute an outline of a diagram that is modified until satisfactory relationships, and a sequence that correctly represents the operation of the product, are obtained. Gaps in the train of logic suggest that functions have been forgotten and need to be found.

In many cases, the study starts from existing products, but FAST is also very easily used for the development of totally new products.

Having defined the general framework within which the scope of the product lies, and the user-related functions having been chosen, the FAST diagram will appear as the general design takes shape.

There will be several diagrams if several design options are considered; just as for existing products there are as many FAST diagrams as there are different solutions.

NOTE: Above, only one presentation of the FAST diagram has been considered, which is now called the Technical FAST. Another and more recent presentation is the Commercial FAST (or Customer FAST). It is a function tree. Inside the part which concerns the scope of the problem, the main service functions appear in the upper left part of it (one under the other and in principle independent of each other). Those, on their right, are translated into product-related functions that are logically linked, as we have seen previously.

Again in the left part of the diagram, under the main service functions, other service functions are introduced, grouped into logical families, for example:

- to ensure convenient use (easy installation, user information, easily repairable, etc.);
- to ensure availability (reliable delivery, resistance to injury from an external cause, etc.);
- to satisfy the user (integration into the environment, generation of minimum noise, etc.)

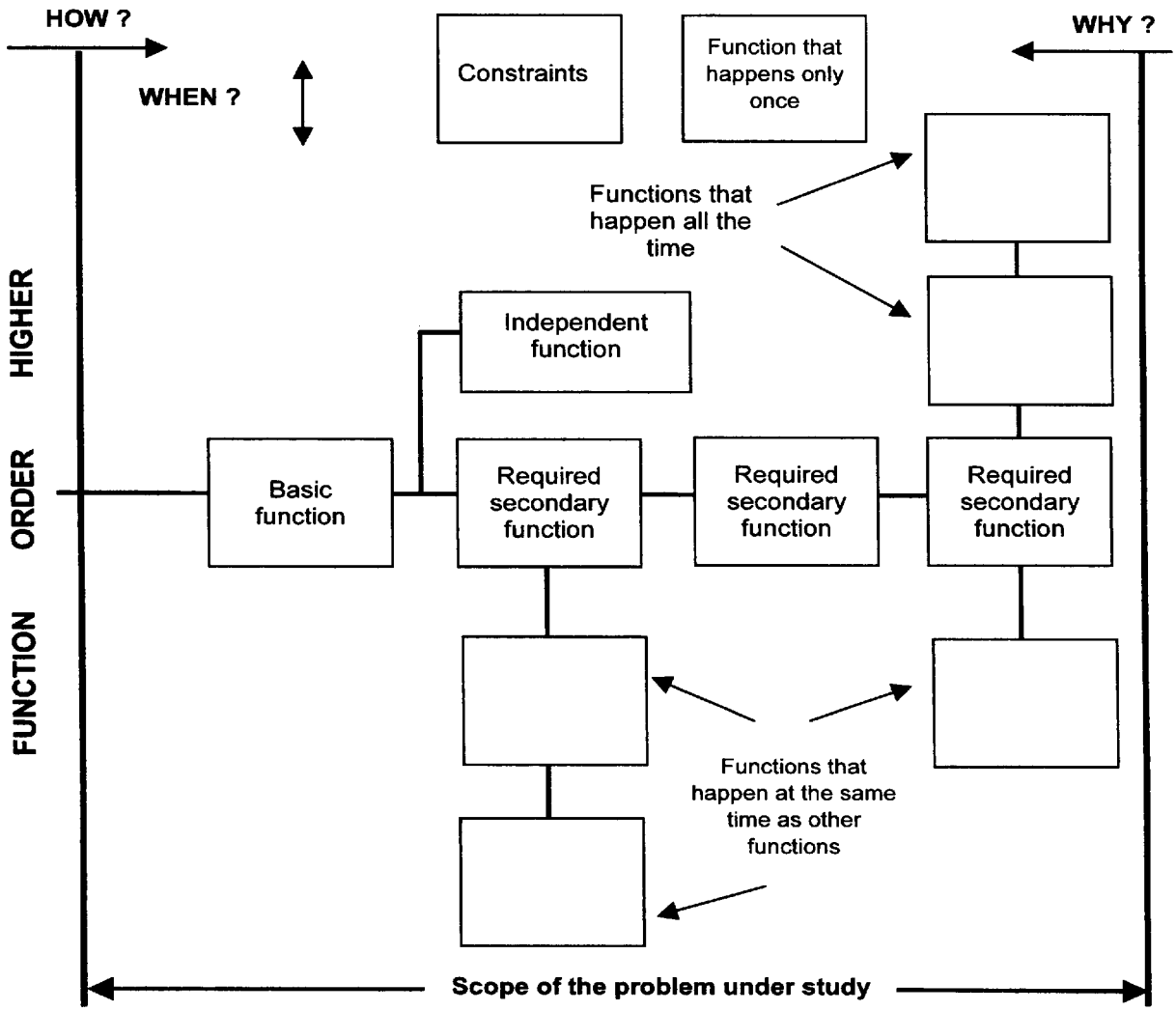

Figure A.2 — Function Analysis System Technique: FAST-Diagram

NOTE: FAST is a tool which was developed in the United States and the names they usually give to the functions in the diagram have been adopted, although they are not consistent with the definitions of EN 1325-1.

(d) Other FA methods
While preceding methods have been developed in the framework of VM, the methods that will now only be mentioned have been conceived in another context, often for specific needs.

They generally apply later in development (devising solution architectures, etc.) and are implemented especially if the product contains function flows that are to be processed (energy flow, information flow, etc.).

The initial method, commonly called SA (Structured Analysis) applies essentially to the description of the logical functioning of industrial products with few physical movements inside them.

The method rests on the following **principles**:

- to analyse and understand a system, it is necessary to build a model that allows the most relevant questions to be asked;

- the analysis of the product (i.e. the construction of the model) is managed in a downward, hierarchical, modular and structured way.

SA provides elements to model the functions and data of the system. The model provided by SA is based on the graphic method to facilitate communication.

Application to products with many physical movements gave rise to better performance tools in order to take account of the notion of time in the progress of the processes or decision making.

Examples for such tools are:

- SADT (Structured Analysis Design Technique), a trade mark of Softech USA, that allows a future or existing product to be described in the form of a model;

  SADT manages the transformations brought about by a process. The models are functional and conceived as a combination of functions transforming "input" elements of each function into "output" elements. The latter can constitute input elements of another function;

- the tools IDEF 0, IDEF 1, IDEF 2, SA-RT, etc. offer similar possibilities and have not been copyrighted. They are characterized by the fact that they use specific semantic and symbolic approaches.

Their implementation can be aided by computer softwares.

(4) The organization of the different Functional Analyses

FA may be developed progressively throughout a lengthy study. At each stage care should be taken to incorporate any changes or developments since the previous stage.

(5) Conclusion

To apply Functional Analysis means, with regard to user-related functions, the acquisition of a really representative knowledge of the objective.

The discipline has been enriched over the course of time and methods have emerged to widen the scope of applications and to facilitate implementation.

We thus have today a range of techniques that allows us to apply a functional approach during a whole project (see Figure A.3), from the inception of the need identified and its formalization, to the studies of the way the system operates. This helps the development of the overall concept considered, then its detailed design, or the building and then the checking of its relevance through dependability studies.

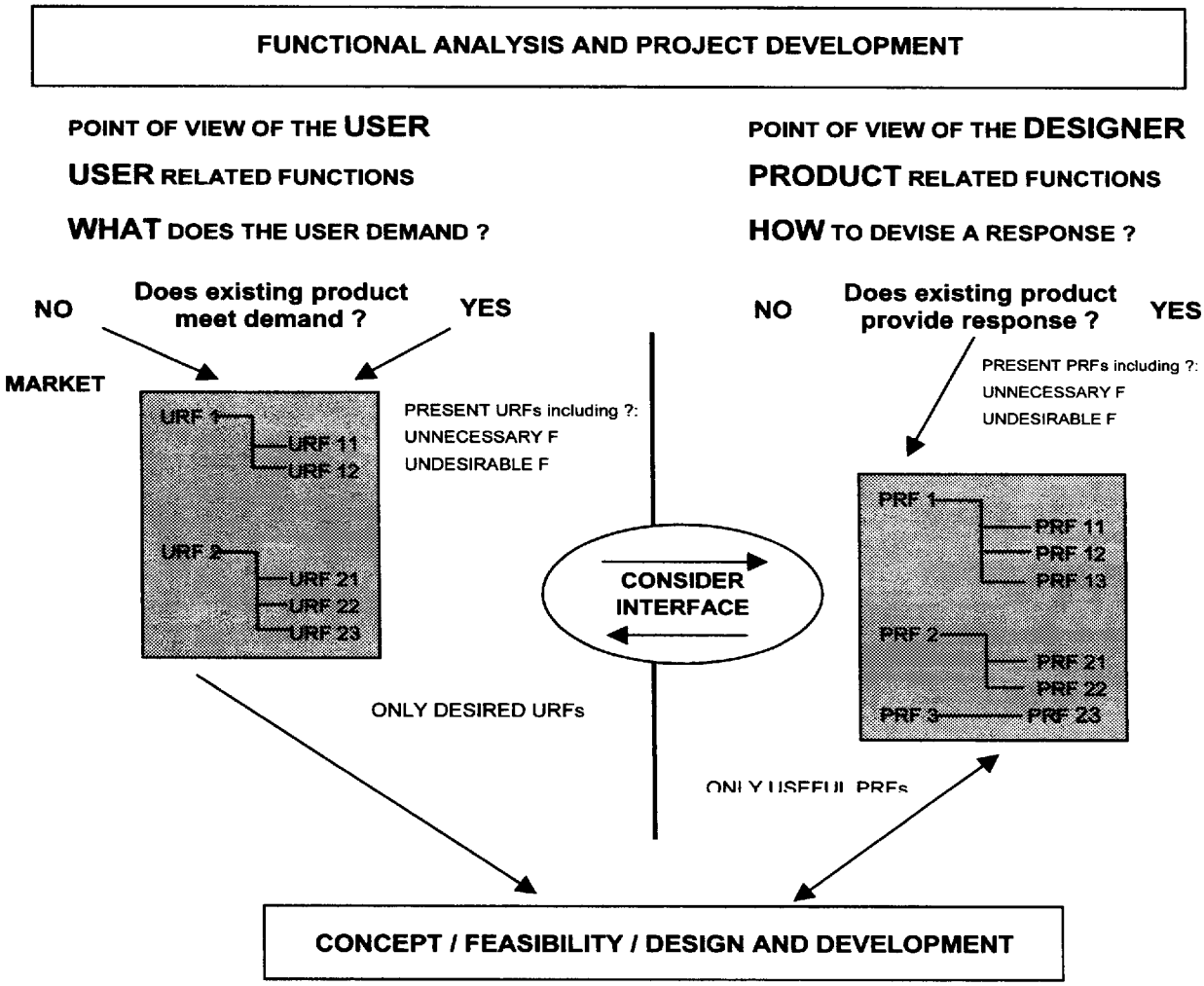

Figure A.3 — FA and project development

A.1.3 Function Cost (FC)

A.1.3.1 Presentation

Costs calculated by conventional procedures are usually expressed on an elemental basis. Reallocating costs to the functions of a product provides new insights to the way we consider that product.

A function cost is the total of the expenditure (use of resources) predicted or incurred in providing a function in a product. The sum of the costs of providing all the different functions equals the total cost of the product. Determining function costs is part of the FA process.

NOTE: This section only refers to initial costs. Whereas the life cycle cost of the whole of a product is often to be considered, those of isolated functions can rarely be significant and are not usually considered.

A.1.3.2 Detailed description

(1) Characteristics

Before design or development and realization of a product is completed, function costs are targets or estimates. After development, function costs are the costs which have been effectively incurred.

Function costs cannot be precise and unquestionable. When URF costs are targets or limits, they are based on marketing considerations and the technical feasibility.

When URF (user-related function) or PRF (product-related function) costs are considered for an existing product, industrial engineering data and estimates are used, but these are usually available for parts or sub-assemblies only, not for functions.

(2) Implementation

To calculate or evaluate function costs, two methods are generally used according to whether it is possible:

- when starting with a given solution, to add (or delete) one specific function; the cost difference gives an estimate of that function cost;

- or, to roughly distribute the cost of parts or sub-assemblies between the functions they perform, or between the functions whose performance they contribute to; adding the cost contribution of each part or sub-assembly gives an estimate of the cost of each function. A function cost matrix used to make these calculations is shown below (see table A.3). Such a task can only be accomplished by an experienced working group.

Table A.3 — Function Cost Matrix

Functions / Components	F 1		F 2		F 3		Costs of components	
	$	%	$	%	$	%	$	%
Component 1	a				b		a + b	
Component 2			c		d		c + d	
Component 3	e		f				e + f	
Costs of functions	a + e		c + f		b + d		a + b + c + d + e + f	

(3) Uses

We can investigate both user-related function costs and product-related function costs. Both are important to consider, because:

- it means that the organization has the necessary expertise to compare equivalent parts or sub-assemblies of different solutions which perform the same or equivalent function or set of functions;

- it makes it possible for the VM team to concentrate preferably on the higher cost functions as these usually offer the best potential for improvement.

It is essential to consider user-related function costs because:

- it makes it possible to examine whether these costs correspond to the importance of the functions for the user;
- it is the main means of dialogue between the marketing people and the development team, for instance when the level of performance of a function is questioned, or when the addition or deletion of a secondary function is envisaged;
- it is an indispensable element for management for trade-offs and decisions.

A.1.4 The Functional Performance Specification (FPS)

A.1.4.1 Presentation

A Functional Performance Specification is a document by which an enquirer expresses their needs (or those they are responsible for expressing) in terms of user-related functions and constraints. For each of these, evaluation criteria are defined together with their levels, with a certain degree of flexibility being assigned to each one.

The expression of these user's needs in the FPS is made in functional terms, without reference to the technical solutions that may satisfy them, and with a minimum of constraints.

This allows the enquirer to obtain from the designer, manufacturer or supplier the design, the realization or the proposal for the most efficient product, that will be the most advantageous for the user.

To achieve this it is necessary that every opportunity should be explored and that the terms of the Functional Performance Specification should stimulate the designer, manufacturer or supplier to optimize the product or to find the best proposal. This implies that the possible flexibilities should be indicated. It encourages constructive dialogue between a client and a supplier or contractor.

The FPS encourages the examination and the comparison of different proposals on a functional basis, the framework of which is given by the FPS and used in the supplier's response.

A.1.4.2 Detailed description

(1) Constituent elements of a FPS

(a) General presentation of the problem
The general concept of the product is presented to the designer, manufacturer or supplier to allow rapid and clear understanding of the problem and to allow the main needs to be satisfied (this is a summary of the functional expression of need; see A.1.2.2).

Indications on the market (existing products, market importance, commercial life forecast) are given to complement the information and motivate the designer, manufacturer or supplier. The context of the project and objectives have to be specified: whether the project is part of a larger programme, already undertaken or under way, whether there will be further developments, etc.

Finally, the environment and its constraints will be specified (persons and social context, other equipment, etc.).

(b) Functional expression of need
The functional expression of need is the result of a thorough functional analysis and constitutes the main part of the FPS.

It specifies:

- user-related functions and constraints (the latter, which limit the freedom of the designer, manufacturer or supplier, will be reduced as much as possible);
- corresponding appreciation criteria;
- the level of these criteria, indicating:
  - those which are imperative (with a certain tolerance);
  - those which are desired but open to negotiation, subject to limits of acceptance and flexibilities (either qualitative ones and several classes of greater or lesser flexibility can be used, or quantitative ones, and "cost/level of criteria" trade-off ratios will then be set).

The functional expression of need will preferably be presented in a summarized and concise form. The use of charts, graphs, diagrams or trees which present what is called the function structure, accompanied by comments, is generally preferable.

A reference price or a cost is often introduced, globally or for some functions, and the trade-off ratios can apply to the levels of criteria and to the function costs given as a reference.

(c) Call for variants
The call for variants of the FPS concerns variants of the functional expression of need that the designer, manufacturer or supplier can propose as compared to the one the enquirer has set in the FPS.

It shall be clear that, systematically, the enquirer will attentively examine the suggestions that the designer, manufacturer or supplier can make, considering that an indication of the general problem to solve has been given to the enquirer.

These suggestions will be totally unrestricted, but in addition the enquirer can indicate particular directions in which the enquirer wishes to receive proposals from the designer, manufacturer or supplier.

The call for variants stimulates innovation and allows exploration of both ambitious and realistic solutions.

(d) Framework of answers
In the case of multiple offers and so as to facilitate their examination, it is imperative to set a framework of answers for designers, manufacturers or suppliers. This is to enable each proposal to be compared like for like. This framework of answers, which is part of the FPS, only considers aspects directly linked to the product, e.g. operation, unit price, realization.

The same functional presentation used by the enquirer to describe needs has to be used as well by the designer, manufacturer or supplier to present his proposal.

The answer framework explains and describes the proposed solutions and comprises at least an evaluation table in which the designer, manufacturer or supplier indicates, for each function and for the whole product, among other things:

- the nature of the proposed solution (with economic and technical justifications of the choices that have been made);
- the levels reached for each of the appreciation criteria (and the proposed methods for their examination);
- the part of the price corresponding to each function, if possible;
- the arrangements made to meet constraints, to what level it is performed, and the costs which have been incurred;
- the related costs which are to be expected, such as user training, operation, maintenance, etc.;
- the predicted level of reliability (assuming it was not specified in the appreciation criteria); etc.

(2) The elaboration of a FPS

(a) The participants individually, and the working group as a whole
Participants in drafting a FPS are:

- the **enquirer**; the enquirer may be an organization asking for a product from a supplier, in which case the enquirer has a representative who may be the decision-maker of a VM project; the enquirer may be a manager in the organization who requests some product from another department in the organization; in both cases the enquirer defines the question which is to be considered, sets some objectives (prices, time limits, etc.), the outline of the general presentation of the problem, and chooses a team leader for the working group which will be set up;
- the **team leader**, who selects the members of his working group, coordinates their action, distributes the tasks to be performed and undertakes some of these tasks, and leads the group in its principal job which is functional analysis;
- the **working group** whose members are selected for their complementary skills and competence in defining the need and in knowing the application of the product that shall meet that need; the members are also competent in the areas of supply distribution, maintenance, and storage; the same principles that govern the setting up of the working group for a VA study apply here;
- possibly the **designer**, **manufacturer** or **supplier**, especially if they belong to the same organization as the enquirer, either occasionally or throughout the drafting of the FPS; but even when the designer, manufacturer or supplier is an external supplier, one of the possible suppliers can be called in as an expert, especially when the technical aspects lie outside the field of the working group; when inviting a potential supplier to contribute to the drafting of an FPS, particular precautions concerning confidentiality or industrial property have to be taken.

(b) Work plan
(see table A.4).

(c) The evolution of a FPS over the course of time
The characteristics and the degree of precision of a FPS vary according to the current phase of the product creation, when it is a complex one, or to the phase of study of the system into which the product to be obtained will be integrated.

The FPS may evolve during the progress of a complex project before a technical specification is reached.

Alternatively, for a simple product, a FPS will be relatively easily and quickly achieved, and its definitive form will be reached very rapidly.

The different uses of the FPS and the particular forms it can take are considered in more detail below in (3) (a).

(3) The use of the FPS

This paragraph particularly illustrates the implementation of the FPS in the case of the study of products of average complexity.

(a) The evolution of the FPS and the progress of a project
The enquirer writes a first version of the FPS, sometimes called an FPS 0, that will be transmitted to potential suppliers to ascertain their position and obtain their response in terms of feasibility. This version, comprising the maximum of flexibilities, will be amended to take into account their remarks and suggestions.

A stabilized version is thus achieved that will be the basis for consultation or a call for tenders.

The different competitors will take advantage of the remaining flexibilities to prepare the proposal that seems to them the most satisfactory. These proposals, written according to the answer framework included in the FPS, will be objectively compared.

The last options having been specified, it may become necessary, before issuing the order for the supply of the product, to establish a technical specification.

(b) The FPS of the feasibility study, the FPS for obtaining price proposals
According to the state of advancement of the project, FPSs can be written with very variable degrees of precision.

At the start of a project, a very general FPS may be written to ascertain the feasibility of a project and whether it is economically justifiable.

This document will then become more complete and precise in order to constitute the basis of a pre-project, then a development project and a supply proposition.

(c) The response to a FPS
Here only the case of the external use of an FPS will be considered.

The designer, manufacturer or supplier shall first effectively take into account the whole of the need expressed in the FPS before working on the development of an answer.

The degree of precision of that answer shall be coherent with that of the FPS sent to obtain supplier proposals, in order to avoid expenditure on unnecessary study.

This answer should in principle insist on the functions and the levels of performance the product is capable of, not stressing, as is usually the case, the technical description of the proposal only.

The designer, manufacturer or supplier shall also consider the FPS as a dialogue tool. By taking advantage of the flexibilities and of the call for variants, the FPS makes it possible to constitute real power of proposal and participation for the benefit of the enquirer.

(d) Kinds of uses of the FPS
Two main kinds of uses of the FPS should essentially be distinguished:

- internal use in the progress of a project;

- external use between different organizations.

Internal use of the FPS

For many projects, the functional description of the product that is to be developed, made during the VA study, is sufficient.

Nevertheless, if the importance of the project justifies it, or if the staff of the enterprise that have to express the need on the one hand, or to develop the solution proposal on the other, cannot together easily constitute one working group, it may be necessary to work out an FPS. In that case, a team will be put in charge of writing it. That team will be composed of people having the necessary competence to formalize the need.

In the subsequent uses of the FPS, the two groups can continue to exist and play their respective part in the dialogue that is established between the enquirer and the designer, manufacturer or supplier in order to develop the solution which is the best compromise.

External use of the FPS

Two cases are met:

- either the FPS is established as the essential element for the design and development process of a complete system by a specialized supplier;

- or, in the framework of the development of a complete product, an organization can write a FPS to consult suppliers in order to obtain a subassembly or an important component.

Table A.4 — Functional Performance Specification work plan

Basic Phases	Elementary Steps	Comments on the elementary steps	The tools used * specific VM tools
1 Definition of the product needed	1.1 Definition of the product		
	1.2 Principal objectives	Price, time limit for the elaboration of the FPS, for the answer to the FPS	
	1.3 Context of the project 1.4 Choice of a team leader, of a decision-maker if suitable		* Definition of the requirements for a team leader
2 Collecting the information	2.1 The market: - existing products; - market importance; - commercial life prospect.		
	2.2 Context of the project	Possible situation in a larger programme	
	2.3 Already carried out or studies under way		
	2.4 Miscellaneous	Standards. Patents. further developments	
3 Functional analysis	3.1 Identification of user-related functions	For the different phases of the life cycle of the product	* Functional analysis techniques
	3.2 Structuring and arranging in a hierarchical order of service functions		* Presentation of functions (diagrams, functions trees, commercial FAST)
	3.3 Identification of indispensable constraints		
	3.4 Characterization of service functions and constraints		
	3.5 Function costs objectives		
4 Carrying out the other elements of the FPS			
5 Writing and validation of the FPS	Writing of informative appendices, too, if suitable		
6 Presentation and agreement of the FPS			

A.1.5 Design to Cost (DTC)/Design to Objectives (DTO)

A.1.5.1 Presentation

Design to Cost is an anticipative management method which, from the start of the development programme of a product or system, takes the production costs into account. It does so until the end of development, when industrial costs consistent with the goals that were aimed at are obtained.

The anticipated production cost is considered as a performance that shall be attained, as well as the technical performances, which can even be reduced if necessary. During development, a balance between cost, performance and schedule will be a permanent and continuously assessed concern.

DTC makes it indispensable to have a management procedure which is supported by a continuous exchange of information and coordinates actions between customer and contractor, or contractor and sub-contractors. From the start of the programme onwards, it requires organization, procedure trade-off rules, and cost estimating tools.

DTC requires a plan that describes all the tasks, from the beginning to the end of the programme.

Design to Cost (DTC) evolves into Design to Objectives (DTO) when objectives other than costs are considered.

NOTE 1:DTC monitors the trade-offs between cost, performance and schedule, these being attained through the best available tools. This leads to emphasizing the importance of Value Analysis for a DTC management of a project, although VA and DTC are distinct methods. DTC does not imply that VA should compulsorily be used.

NOTE 2:On the contrary, Functional Analysis is one of the steps of the DTC process. This highlights the relationships between VM methods and tools.

A.1.5.2 Detailed description

(1) The start of DTC

DTC was created in the United States by the Department of Defence (DoD). It had observed that major armament programmes were continuously overspending and this had to be halted.

Studying the reasons showed that there were insufficient specifications, together with the fact that industrial companies were inclined to make improvements, whilst military clients were continuously more demanding.

Since 1971, the DoD has made DTC compulsory on all contracts for the army in excess of 10 million dollars.

For DoD programmes, DTC has **4 phases**:

a) programme initiation:

   1) mission feasibility and concept formulation;
   2) concept exploration;

b) demonstration and validation;

c) full-scale development;

d) production and deployment.

Each of these phases depends on the decision of the Secretary of Defence and each of them is covered by an adequate contract.

(2) The development of DTC and current practices

In the USA different uses of DTC have emerged for industrial contracts just as they have in other countries. They are considered below.

When a development programme is received by a contractor from an important client where DTC is compulsory, the DTC objectives or targets have already been set by the client:

- where the contractor is the sole source for a product or system, strong incentives are included in the contract to meet DTC objectives, given that the development contractor is certain of being the production contractor;

- where competitors exist, if the contractor for the first phase fails to meet DTC objectives, the client has the option to place the remaining phases of the contract with a competitor; to win the next phase of the contract provides a strong motivation for the contractor and the incentive may be less.

NOTE 1: In a competitive situation, there are successively several development contracts, one for each phase; DTC goals are set for each of these contracts.

NOTE 2: In a sole-source situation, there may be only one contract; in any case, provisional DTC objectives are fixed first. Later, as information becomes available, these become definitive objectives which are set at the latest at the beginning of phase 3, full- scale development; moreover, "thresholds" are established which, if crossed, lead to the project being terminated or reconsidered.

NOTE 3: The client may establish a DTC contract with his supplier (or prime contractor), and have his prime contractor establish his DTC contracts with the main sub-contractors.

NOTE 4: Instead of taking into account the trade-off rules mentioned above, the exchange of information and trade-off decisions can be more precise when carried out in reference to a Functional Performance Specification (either a system FPS, where a client and prime contractor are concerned, or sub-system FPSs where a prime contractor and sub-contractors are concerned).

A development programme may be obtained by a contractor from an important client without DTC obligation. In this case, the contractor may independently organize DTC development both for the work carried out in-house and that carried out by partners or sub-contractors.

An organization may, on its own initiative, decide to develop a product or system for the market, most of the work being carried out inside the company; that organization may organize DTC management of the programme.

(3) Fundamental elements of DTC

The fundamental elements of DTC are as follows:

(a) Evaluating the programme's basic factors
The programme's basic factors are evaluated, among which are the objective costs which include the production cost. This is specified for the production rate and total quantity defined in the programme.

(b) Functional analysis
See A.1.2.

(c) Study of solutions
Study of solutions based on a cost-performance optimization, the constraints of the programme being taken into account (use of Value Engineering).

(d) Monitoring objective costs
Continuously monitored objective costs, to be expressed in inflation-adjusted currency units.

(e) Splitting-up into sub-assemblies and tasks
Splitting-up of the work to be done into sub-assemblies and tasks.

(f) Splitting-up of the objective cost
Splitting-up of the objective cost in accordance with the number of sub-assemblies and tasks.

(g) Technical and economic reviews
Technical and economic reviews (to be made systematic during and at the end of the programme phases).

(h) Economic and technical risks
Economic and technical risks are to be taken into account.

(i) Organizing production
Organizing production in order to control expenses and to stay within the cost objective, using VA.

The DTC Manager and a Programme Manager are responsible for all those fundamental elements, as well as for the corrective actions.

(4) About cost estimates

There are 4 classes of cost estimates, their use depending on the programme phase concerned:

a) expert opinion;

b) analogy approach;

c) parametric estimating;

d) detailed estimates (industrial engineering).

In each case, the degree of confidence in the estimates shall be justified. The estimates shall be made using appropriate tools, including data bases.

(5) DTC work plan

The usual work plan is detailed in table A.5.

(6) From DTC to DTLCC and DTO

When DTC was introduced, there was not usually sufficient information about the expenses incurred by a product or system during its life cycle.

When this information became available and the requirements of the users of important systems became more demanding, life cycle cost was added to cost as another parameter against which the functions or their performances were to be traded-off.

DTLCC or Design to Life Cycle Cost supplemented DTC for many development programmes.

Nowadays, as has been previously explained, the trade-off of functions or of their performances has often to be made against other factors such as resources, time or delivery, weight, energy consumption, etc. Management has to determine the factors that are relevant in the prevailing circumstances, and to the objectives that are to be met. DTO or Design to Objectives sometimes replaces DTC and DTLCC.

Table A.5 — Design to cost work plan

Basic Phases	Activities	Detailed principles and tasks of the processes
0 Mission feasibility and concept formulation	Technology advances	Principles for developing new technology
	Mission feasibility and utility analysis	Conceptual phase decision highlights
		Development phase decision highlights
		Production phase decision highlights
1 Concept exploration	Performance requirement analysis	Cost effectiveness analysis
	Requirement definition and specification	Specification practices
		Configuration and data management
		The review process
	Requirement allocation	Cost effectiveness analysis
		Setting Design to Cost goals
	Operational trade-off	Managing trade-off studies
	Functional trade-off	Cost effectiveness studies
		Managing trade-off studies
	Technology and risk assessment	Cost effectiveness analysis
		Risk Management
	Interface definition	Cost effectiveness analysis
		Specification practices
	Functional baseline development	Cost effectiveness analysis
		Specification practices
		Configuration and data management
	System requirement review	Cost effectiveness analysis
		Specification practices
		Configuration and data management
		The review process

continued

Table A.5 *(continued)* — Design to cost work plan

Basic Phases	Activities	Detailed principles and tasks of the processes
2 Demonstration and validation	Allocated baseline definition	Functional responsibilities Specification practices
	Element specifications	Specification practices
	Performance, cost and schedule refinement	Technical performance measurement
	Interface specifications	Specification practices
	System integration planning	Organization for DTC Functional responsibilities
	Configuration management definition	Specification practices Configuration and data management
	Risk management planning	Organization for DTC
	Production capability assessment	Production readiness
	System engineering management plan (SEMP)	System engineering process Organizing for DTC Functional responsibilities
	System design review	The review process Production readiness
3 Full-scale development	SEMP implementation	System engineering process Organizing for DTC
	Documentation up-date	Configuration and data management
	Configuration management	Specification practices Configuration and data management
	Human factors and training planning	Functional responsibilities
	Preliminary design review	Configuration and data management The review process
3 Full-scale development (to follow)	Critical design review	Configuration and data management The review process
	Functional configuration audit	Configuration and data management The review process
	Production baseline development	Specification practices Configuration and data management Production readiness

continued

Table A.5 *(concluded)* — Design to cost work plan

Basic Phases	Activities	Detailed principles and tasks of the processes
4 Production and development	Production engineering	Manufacturing resources planning Production readiness
	Production readiness review	Configuration and data management The review process Production readiness
	Physical configuration audit	Configuration and data management The review process Production readiness
	Technical data package preparation	Configuration and data management
	Modification management	Functional responsibilities Configuration and data management
	Life extension planning	Activities by contractual phase
	Operation and support	Cost element structures

A.2 Other methods and tools

It has been stated that a VM study may involve the use of many different methods, the choice of which methods to use being dictated by the subject and objectives of the study rather than the prevalent competencies within the organization.

There are numerous management methods and tools, some formal, some less so, which may be applied within a VM Programme.

The following table lists some of these and positions them in the context of VM. The examples are not exhaustive nor are they exclusive, since new methods will continue to be developed. The methods and tools are listed without any order of importance.

Table A.6 — Additional methods and tools and their main uses in Value Management

Method/Tool	Main Uses in Value Management
Benchmarking	Discovering best practice and setting targets
Business Process Reengineering	Radically improving business processes
Cost-benefit Analysis	Assessing the value of unmarketed attributes
Cost modelling	Building cost models in order to analyse the effects of changes
Creativity techniques	Generating innovative ideas
Design for Manufacture and Assembly (DFMA)	Working out optimized realization processes and product designs
Evaluation methods	Selecting options
FMECA	Identifying modes of failure and their consequences
Industrial Design	Designing products with an appealing image for the customer
Kaizan	Bottom up continuous improvement
Life Cycle Costing (LCC)	Estimating total acquisition and operating costs, usually with discounted costs
Market Analysis	Identifying needs for setting strategy and objectives
Operational Research	Cost and performance modelling
Pareto Analysis	Selecting the most important issues to study/act upon
Project Management	Managing a project and the teams involved so as to attain efficiently the objectives set
Quality Circles	Maintaining and improving quality
Quality Function Deployment	Matching customer requirements with design, production targets and know-how
Reliability Analysis	Discovering and eliminating failure causes
Risk Analysis	Identifying hazardous situations, evaluating risks incurred, finding ways to avoid them
Risk Management	Assessing incurred risks and containing them at an acceptable level
Target Costing	Setting objectives and satisfying project requirements within a budget
Target Setting	Setting expectations for performance
Teambuilding	Creating and training work teams
Team Leadership	Inspiring a team to deliver results
Team Work	Managing a team so that it works efficiently
Total Quality Management	Meeting customer and corporate expectations

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