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Guide to the economics of quality —

Part 1: Process cost model

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Quality, Management and Statistics Standards Policy Committee (QMS/-) to Technical Committee QMS/22, upon which the following bodies were represented:

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Contents

Foreword

This Part of BS 6143 has been prepared under the direction of the Quality, Management and Statistics Standards Policy Committee.

This Part of BS 6143, together with BS 6143-2:1990, is an extensive revision and expansion of BS 6143:1981, which was withdrawn upon publication of BS 6143-2.

BS 6143-1, the process cost model, sets out a method for applying quality costing to any process or service. It recognizes the importance of process measurement and process ownership. The categories of quality costs have been rationalized to the cost of conformance and the cost of nonconformance. This serves to simplify classification. The method depends on the use of process modelling and the standard gives guidelines on useful techniques. The application of the process control model is compatible within the concept of total quality management.

BS 6143-2, the prevention, appraisal and failure model, is a revised version of the traditional method of product quality costing in manufacturing industries. Improvements have been made in the light of experience and it is recognized that successful practitioners may wish to continue with this approach. Continuation of this approach does not preclude the simultaneous development of the process cost model.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

Total quality management (TQM) requires the management of processes, not just of outputs. This is fundamental to improving quality and productivity in manufacture and service enterprises alike. Every person within the organization contributes to and operates within a process, and every process should have an identified process owner who is responsible for the effectiveness of that process.

Historically, the concept of a quality cost model has suggested that certain identifiable costs are in some way related to the "quality" of the end result. By contrast, within the TQM culture, all business activity is related to processes and therefore the cost model should reflect the total costs of each process rather than an arbitrarily defined cost of quality.

The only partitioning which is ultimately valid is that between the costs of conformance to requirements and the costs of nonconformance. Both are usually capable of improvement. The "process" may be considered at any level within the organization, e.g. the process may be a particular work stage, or it may be the overall process of operating the business. In either case, the process uses materials and resources and the process owner, whether an individual, a supervisor or the managing director, needs the facility to monitor the costs of that process and take action to ensure that these are minimized.

NOTE A new standard guide to total quality management is being prepared as a revision of BS 4891.

1 Scope

This Part of BS 6143 provides guidance on the modelling and determination of costs associated within any business process in a manner consistent with the pursuit of continuous improvement and the concept of total quality management.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6143 the definitions given in BS 4778 apply, together with the following.

2.1
quality related cost

cost in such categories as: prevention cost; appraisal cost; internal failure cost; and external failure cost

NOTE These categories are individually defined in BS 6143-2.

2.2
cost of conformance (COC)

the intrinsic cost of providing products or services to declared standards by a given, specified process in a fully effective manner

2.3
cost of nonconformance (CONC)

the cost of wasted time, materials and capacity (resources) associated with a process in the receipt, production, despatch and correction of unsatisfactory goods and services

2.4
process cost

the total cost of conformance and cost of nonconformance for a particular process

2.5
process

any activity that transforms inputs into outputs, utilizing resources and being subject to particular controls

NOTE Inputs, controls and resources are all supplied to the process.

2.6
inputs

materials and/or data that are transformed by the process to create outputs

2.7
outputs

the result of the transformation of inputs

NOTE In practice the outputs include:
a) that which conforms to the requirement;
b) that which does not conform;
c) waste;
d) process information.

2.8
controls

inputs that define, regulate and/or influence the process

NOTE Controls embrace procedures, methods, plans, standards policies, strategy and legislation.

2.9
resources

contributing factors which are not transformed to become an output

NOTE Examples of resources include people (individuals or groups), equipment, material, accommodation and environmental requirements.

2.10
process owner

the individual who has full responsibility for and authority over the process

2.11
synthetic cost

a cost, derived from available relevant data on a clearly established basis

NOTE An example of a synthetic cost is hours worked × labour rate.

2.12
environment

the external and internal conditions that influence the existence, development and performance of the process

3 The process cost model

3.1 The process

Total quality management (TQM) requires the management of processes, not just of outputs. This is fundamental to improving quality and productivity in manufacture and service enterprise alike. Every person within the organization contributes to and operates within a process, and every process should have an identified process owner, who is responsible for the effectiveness of that process.

3.2 Identification of inputs, outputs, controls and resources

It is useful to construct a block diagram to identify all the elements of the process. It also focuses attention on the need for the process.

The process model should be prepared essentially as shown in Figure 1 and examples of more complex process models are shown in appendix A.

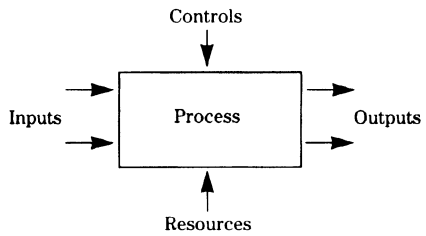

Figure 1 — The basic process model

3.3 The process cost elements

Cost elements associated with the process can be identified and recorded under one of the following categories:

a) people;

b) equipment;

c) materials;

d) environment.

Each individual cost element also needs to be identified as a cost of conformance and/or a cost of nonconformance and the source of the data recorded.

1) ***Cost of conformance (COC)***. The cost of operating the process as specified in a 100 % effective manner. This does not imply that it is an efficient, nor even a necessary process, but rather that the process, when operated within its specified procedures, cannot be achieved at a lower cost. This is the minimum cost for the process as specified.

2) ***Cost of nonconformance (CONC)***. The cost of inefficiency within the specified process, i.e. over resourcing of excess costs of people, materials and equipment arising from unsatisfactory inputs, errors made, rejected outputs and various other modes of waste. These are considered non-essential process costs.

Both areas of cost offer opportunities for improvement.

An operator within a process can usually influence directly only the cost of nonconformance, but he can recommend to the process owner changes that may ultimately affect the cost of conformance.

The owner of the process should monitor the process and make changes that will impact on both parts of the process cost. Some processes exist only because of nonconformance elsewhere, and the need for them may vanish if that nonconformance is removed.

3.4 Preparation of the process cost model

The cost model may be generated for any process within the organization. It may be used to identify and monitor process costs within one particular aspect of the organization such as an invoicing system, works order distribution system or the recruitment process. Alternatively, it may be used to monitor the overall cost e.g. of a department. Examples of cost models are given in appendix B.

The cost model is constructed by identifying all of the key activities to be monitored and listing them as either COC or CONC. The source of the data should also be identified. Ideally, this source of data should be from information already collated within the finance function. In some instances, however, it may be necessary to generate synthetic cost data. This is acceptable within the model, provided the assumptions are clearly stated.

Careful setting up of the cost model is critical to the success of the technique and is the first task of the process owner. Once set up, the model is used for regular reporting on performance. In order to achieve this, the model needs to remain stable to allow comparison with previous periods to be made and cost trends to be monitored. The choice of key activity parameters to be recorded is therefore of paramount importance.

The model should be reviewed early in its use to ensure its effectiveness and thereafter periodically for continued effectiveness.

3.5 Using the model

3.5.1 ***Teams***

It is advisable that quality improvement teams be formed to review particular aspects or processes of the organization. These teams should be encouraged to prepare a process cost model and use this initially in the data collection and analysis phase, identifying opportunities to be investigated, and subsequently during the monitoring phase, in order to report on the improvements achieved.

3.5.2 ***Identify process***

The process should be identified and isolated as a discrete set of activities and given a name. The owner should be identified. The outputs from the process should be identified and each output should be recognized as going to one or more customers. In general, a customer will be the owner of another process.

The inputs to a process should be identified, such as material and data. The controls and resources should also be identified.

3.5.3 ***Identify costs***

Each process will contain a number of key activities. These should be identified. The cost of conformance and cost of nonconformance elements for each activity should be identified and established.

3.5.4 ***Cost report***

The organization should adopt a uniform format for the cost report. The report should contain a complete list of the costs of conformance and nonconformance elements, and should specify:

a) identification of all inputs, outputs, controls and resources of the process being considered;

b) whether actual or synthetic costs are used;

c) the means of calculation for each element of cost;

d) the source of cost data.

The source of data may be an actual cost or a synthetic cost and this information should also be recorded, i.e.

actual cost:	a cost required by the financial system of the organization to be separately identified and recorded;
synthetic cost:	a cost not separately identified and recorded as an actual cost, but derived from available relevant data on a clearly established basis, e.g. hours taken to complete task × hourly rate.

Examples of cost reports are given in appendix C.

3.5.5 ***Improvement process***

A programme of quality improvement activities should be planned, on the basis of information contained in the report, and priorities established. The process owner should consider iterative cycles of improvement using teams or individuals and monitor the resultant cost changes.

From consideration of the initial balance of cost of conformance (COC) and cost of nonconformance (CONC), decisions may be made as to whether the process design or the elimination of waste is the first priority. After improvements have been made, the balance may shift and attention move to the other aspect, this alteration continuing unless other areas of the balance offer greater scope for improvements and returns.

4 Relationship between the traditional (PAF) quality and process cost approaches

In the traditional approach to quality cost modelling, much time is expended in identifying and categorizing costs as prevention, appraisal and failure (PAF). Such categorization may be difficult and unsatisfactory for several reasons, e.g. as follows:

a) Many of the costs can be justified as fitting into any one of the three categories. For example, design reviews may be considered to be a prevention cost; however, they are essentially a checking stage and, as such, could be considered an appraisal cost; but having been introduced to trap design faults at an earlier stage than might otherwise result, they could be considered a failure cost.

b) Allocation of costs to prevention, appraisal or failure tends to divert attention from the true purpose of cost reporting which should be the constant drive ever to lower costs. Thus there is a view that increasing prevention costs indicates an awareness of the costs of quality and should result in a reduction in total costs. Whilst this is true at one level, prevention costs themselves should eventually be a target for reduction, i.e. the category is unimportant. The true value of cost reporting on a consistent basis is the opportunity to measure process performance, introduce changes and monitor the effects of these changes.

There may be, however, a need to link the PAF model with the process cost model, particularly where quality costs have been reported in the traditional manner and are understood and accepted by some people within the organization. In such a case the cost of conformance might initially be considered to comprise prevention and appraisal costs plus the basic process costs, and the cost of nonconformance to be the failure costs.

The cost of conformance merely indicates the cost of satisfying the standards declared. It does not indicate an efficient, or even a necessary process. It should therefore be considered as an opportunity for cost improvement.

Appendix D shows an example of the series of activities needed in the development of a process cost model for the provision of services to the National Health Service. It consists of developing the process model, and then the cost model.

Appendix A Examples of process models

Figure 2 to Figure 5 show examples of process models and illustrate the flow of inputs and outputs.

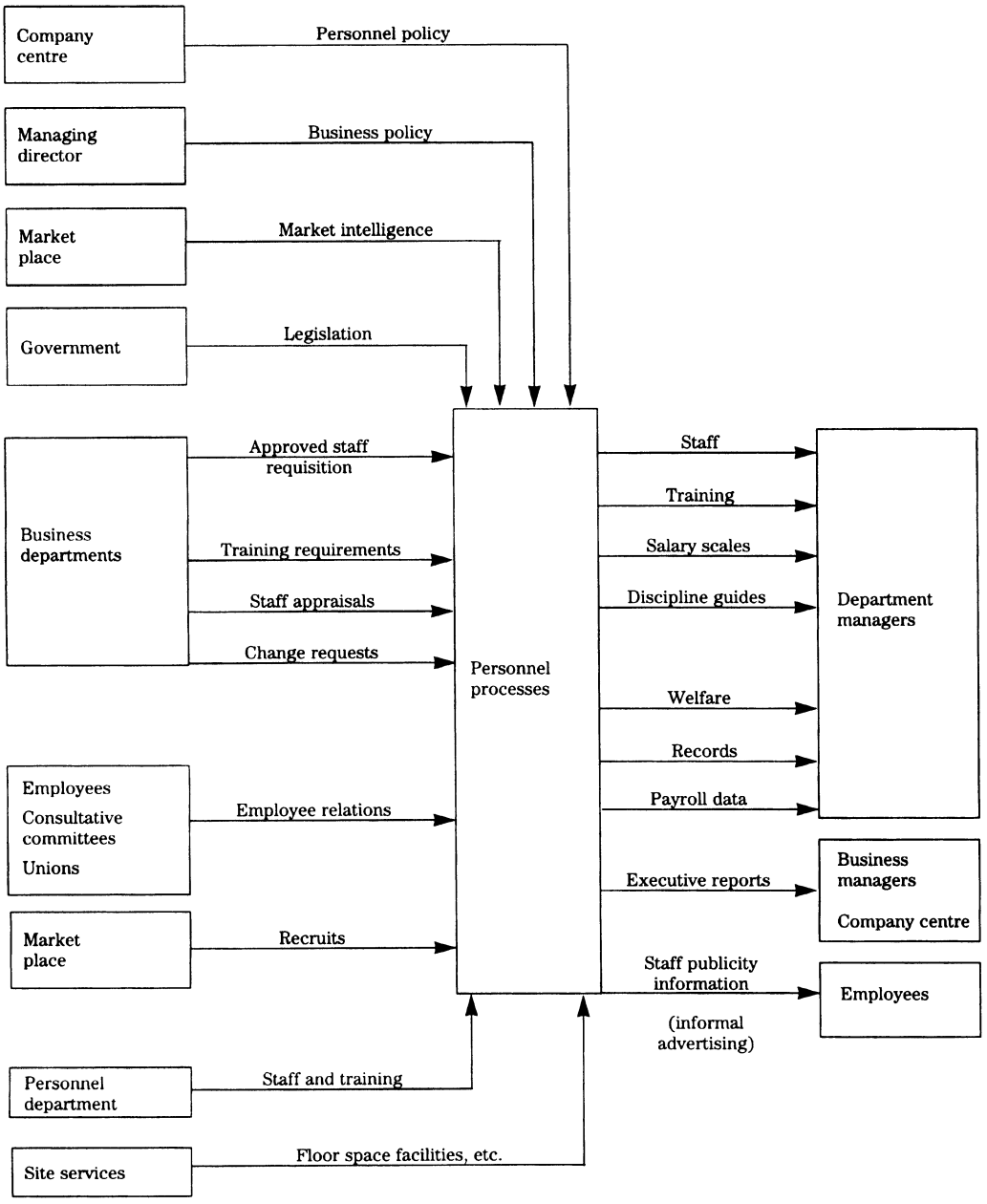

Figure 2 — Typical inputs and outputs of personnel department processes

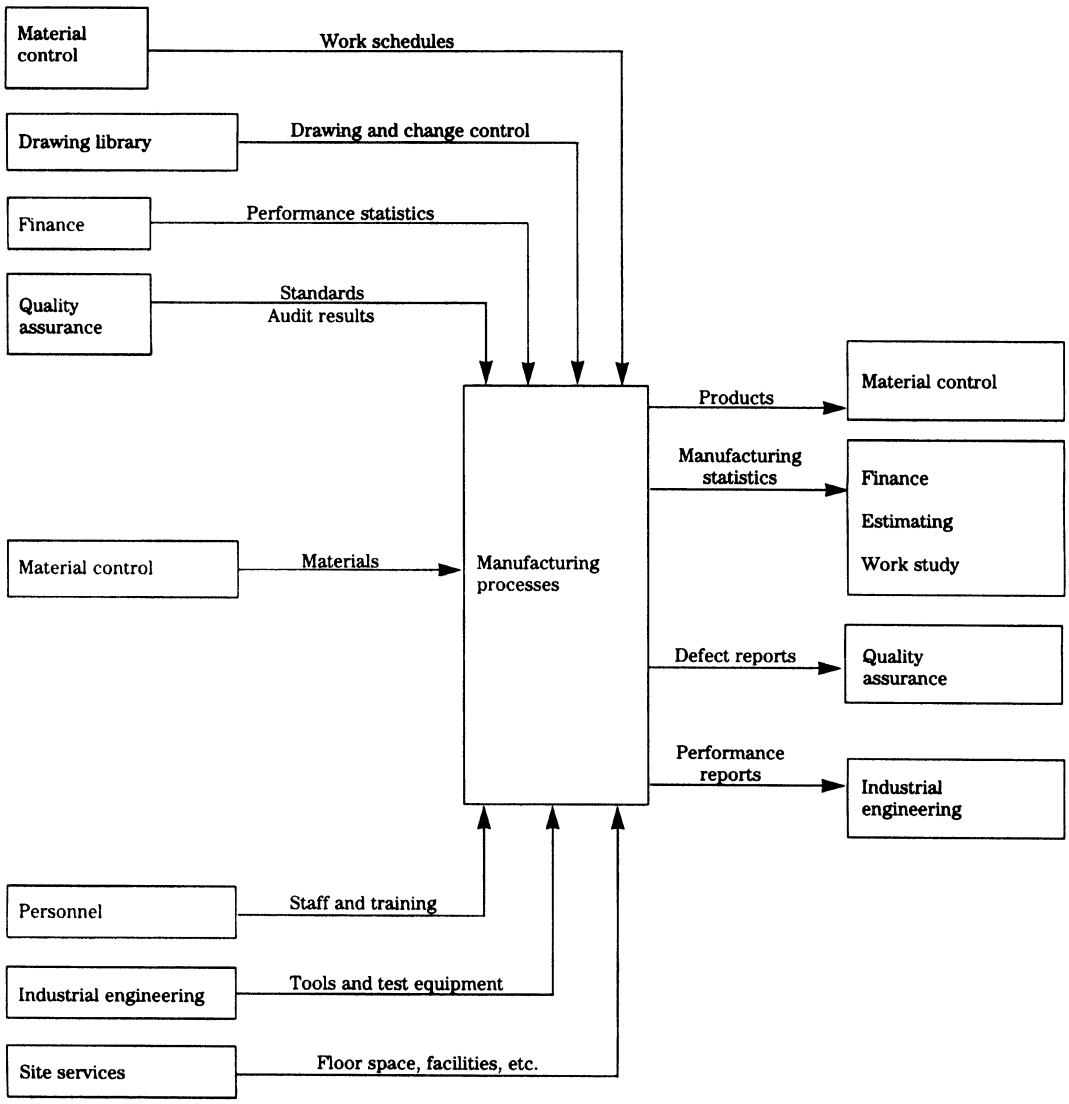

Figure 3 — Typical inputs and outputs of manufacturing department processes

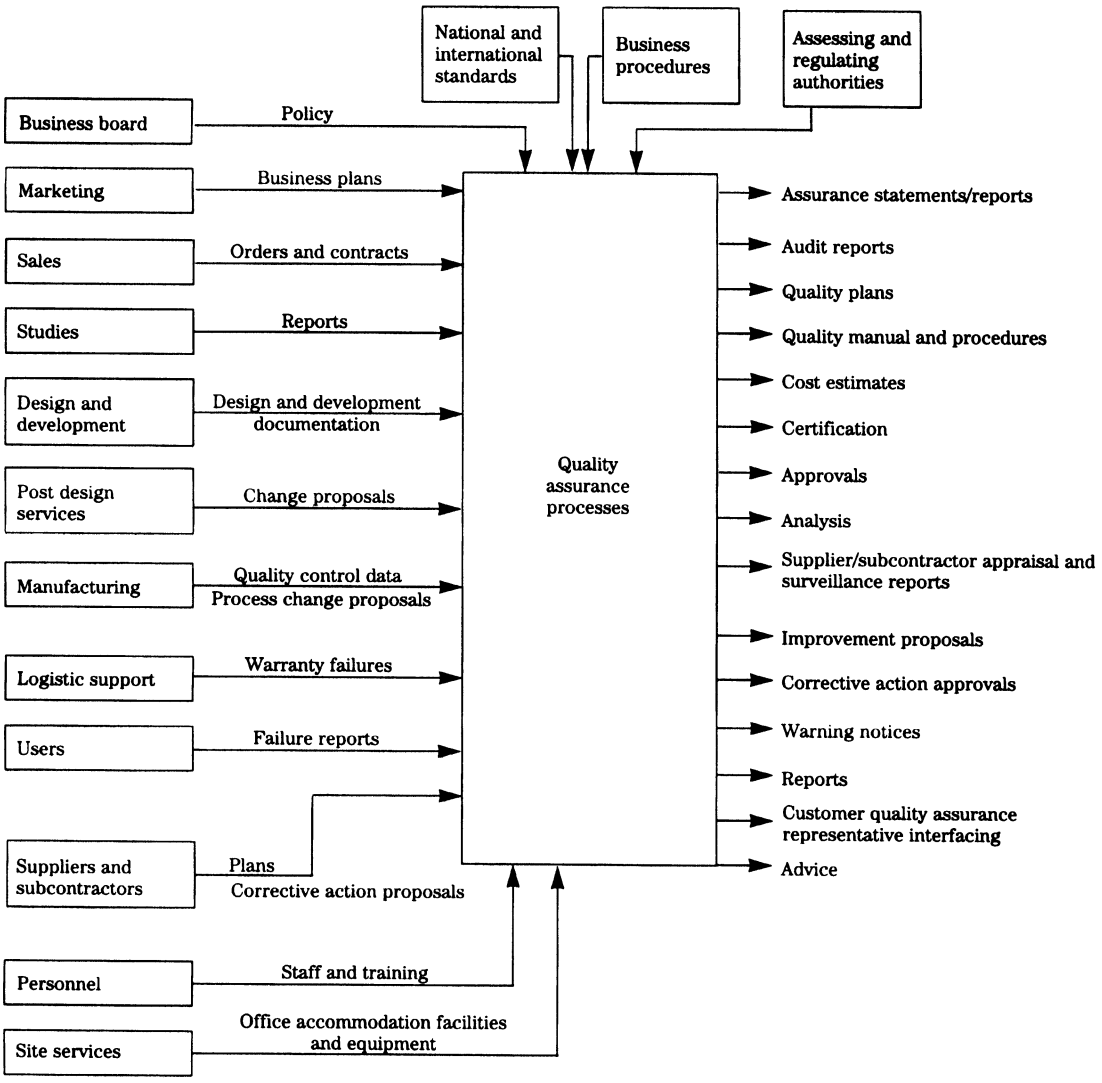

Figure 4 — Typical inputs and outputs for quality assurance department processes

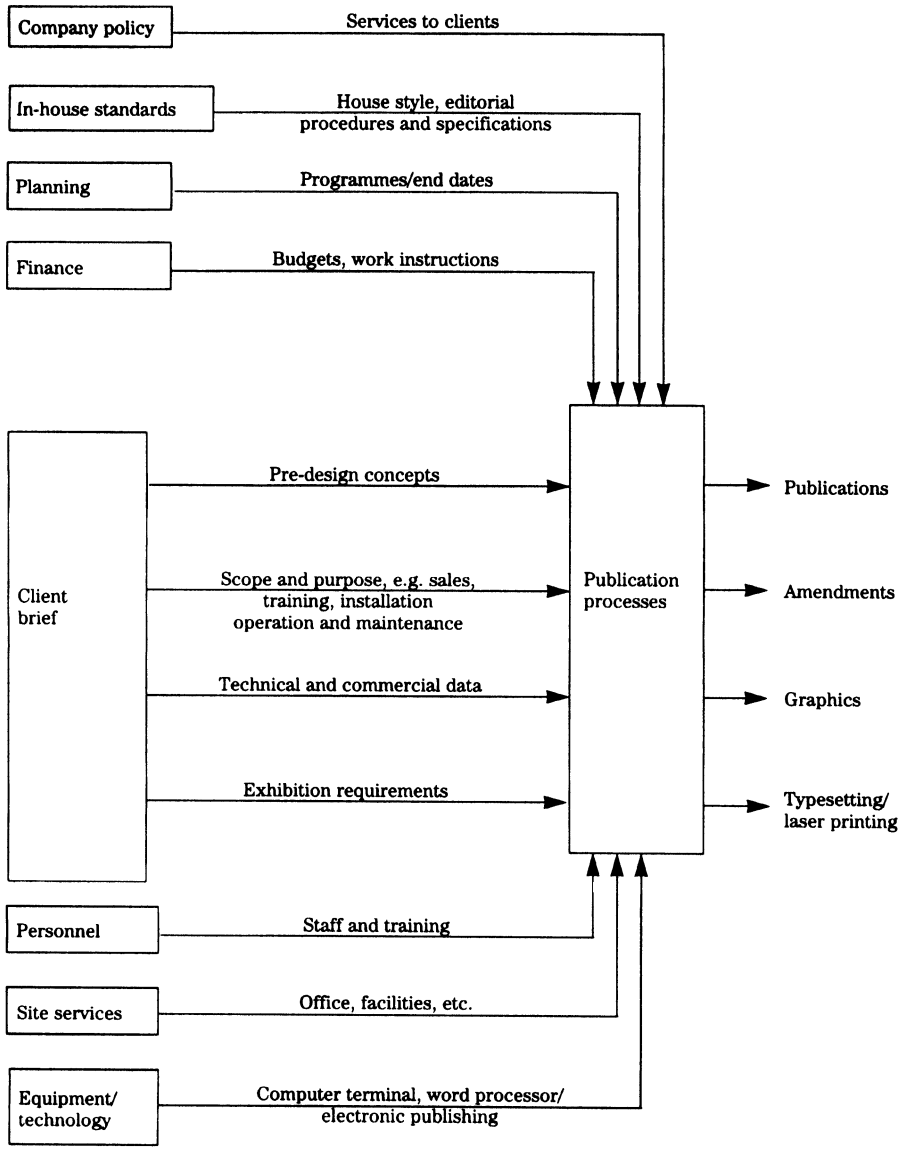

Figure 5 — Typical inputs and outputs for technical publications unit processes

Appendix B Examples of cost models

The example cost models shown in Table 1 to Table 4 identify the key activities for a process and indicate the proportion of cost planned to carry out the process; cost of conformance and the unplanned cost; and cost of nonconformance.

Table 1 — Cost model for a personnel department

Key activity	Cost of conformance	Cost of nonconformance
Attitude surveys	Total cost	
Audit of salaries	Total cost	
Appraisals	Cost of appraisals	Cost of progressing non-returns
Industrial action		Total cost
Staff turnover		Total cost
Recruitment costs	Cost of satisfying requirements	Cost of not satisfying requirements, i.e. delays, etc.
Sponsored students not joining business		Total cost
Training	Cost of training	Cost of cancellations
Grading panel	Cost of grading	Cost of appeals
Personnel change requests	Cost of those approved	Cost of errors, rejections, referrals, etc.
Preparation of statistics	Routine reports	Cost of special reports, chasing inputs, etc.

NOTE See also Figure 2.

Table 2 — Cost model for a manufacturing department

Key activity	Cost of conformance	Cost of nonconformance
Planning, production engineering work study, cost control, materials and process laboratory	Part cost	Part cost (effect of engineering change, planning errors, etc.)
Production inspection and test costs	"Good" hours booked	Reinspection/retest/fault finding
Test gear depreciation, calibration and preventative maintenance	Total cost	
Breakdowns		Total cost
Production costs	"Good" hours booked	Rework
Material costs	Estimated cost	Scrap cost, overspend
Waiting time		Total cost
Cost of work held due to shortages		Total cost

NOTE See also Figure 3.

Table 3 — Cost model for a quality assurance department

Key activity	Cost of conformance	Cost of nonconformance
Audits and reviews	Cost of audits and reviews	Audits of outstanding actions
Vendor appraisals	Total cost	
Vendor liaison	Audit	Failure correction
Produce and monitor quality plans, manuals and procedures	Total cost	
Trouble shooting, investigations		Total cost
Customer liaison	Agreeing and monitoring standards, plans, milestones, etc.	Follow-up actions, e.g. replanning, complaints, rejects, etc.
NOTE See also Figure 4.		

Table 4 — Cost model for a technical publications unit

Key activity	Cost of conformance	Cost of nonconformance
Appraisal of client's requirements and advice to client	Cost of service	Cost of re-appraisal due to change of brief
Client input data; log in, sort and store	Cost of actions upon receipt	Cost of progressing data and items not received
Queries on input data received, and action to address anomalies		Total cost
Author's initial draft	Total cost	
Preparation of illustrations, and graphics	Total cost	
Printing of illustrations and artwork	Cost of first print run	Cost of reprint, e.g. registration, image density correction
Publish draft to in-house approval stage. (Technical and editorial approval)	Total cost to print text and incorporate printed illustrations, assemble and bind	
Correlate and ratify in-house comments and amend draft. Publish first draft to client for comment/approval	Cost to change text and illustrations, update master on publishing system and check. Print, assemble, bind and issue	Cost to make changes due to in-house policy changes
Ratify and incorporate client comments and check status for next draft issue or amendment to first draft	Cost of incorporating minor additional and technical comments. Reissue for approval	Cost of changes due to adverse comments relating to compliance with contractual requirements
Print and issue "final" publication	Total cost	
Amendment to "final" publication	Total cost for variation to contract requirements	Total cost for corrective amendment, i.e. not a variation to contract requirements
NOTE See also Figure 5.		

Appendix C Examples of process cost reports

Figure 6 to Figure 9 show examples of cost reporting using the cost model, all costs whether synthetic or actual use are given in pounds (£) so that totals can be calculated.

PROCESS COST REPORT								
PROCESS Personnel Department			**PROCESS OWNER** Personnel Manager			**DATE**		
Process conformance	**Cost**			**Process nonconformance**	**Cost**			**Cost data source**
	Act.	**Syn.**	**£**		**Act.**	**Syn.**	**£**	
People								
Attitude surveys		✓						Hours taken to complete task × hourly rate
Salary audits		✓						
Publicity		✓						
Appraisals		✓						
				Progressing non-returns (appraisals, etc.)		✓		Hours taken to complete task × hourly rate
				Industrial action		✓		Hours taken during negotiation × hourly rate (total hours for all staff)
				Staff turnover		✓		Termination interviews, hours × hourly rate. Payment in lieu of notice
Recruitment costs to satisfy requirements		✓						Interview expenses, relocation expenses, advertising, labour cost for recruitment staff
				Inadequate recruitment	✓			Special training needs
				Sponsored students not joining company	✓			Cost of sponsorships
Training	✓							Accounts package
				Cancellations or non-attendance at training courses		✓		Cost of training course
Consultative committees, health and safety, grading, union/manager		✓						Total hours spent × hourly rate
				Appeals/failures to agree		✓		Total hours spent × hourly rate
Executive reports (routine)		✓						Hours taken to prepare report hourly rate
				Special reports: statistical, accident, etc.		✓		Hours taken to prepare report × hourly rate
Environment								
Floor space, site changes	✓							Accounts package: floorspace, site services, telephones, site administration
Materials and methods	✓							
Training material, site publications								Invoiced cost
Personnel manual, directives, health and safety guidance		✓						Hours taken to prepare information × hourly rate
Total process conformance cost				Total process nonconformance cost				
Prepared by								
NOTE See Figure 2 and Table 1.								

Figure 6 — Typical process cost report for a personnel department

PROCESS COST REPORT								
PROCESS Production Department				**PROCESS OWNER** Manufacturing Manager				**DATE**
Process conformance	**Cost**			**Process nonconformance**	**Cost**			**Cost data source**
	Act.	**Syn.**	**£**		**Act.**	**Syn.**	**£**	
People Assembly, inspection and test	✓							Produced hours × hourly rate from accounts package
				Hours taken of rework, reinspection, retest	✓			Excess codes: hours × hourly rate from accounts package
				Waiting time	✓			Excess code: hours × hourly rate from accounts package
Equipment Cost of capital equipment to carry out work, i.e. depreciation, calibration, maintenance, chronos	✓							Accounts package: capital assets inventory × (manufacturing efficiency)
				Cost of capital equipment to carry out rework, etc.	✓			Accounts package: capital assets inventory × (1 – manufacturing efficiency)
Environment Floor space, maintenance facilities, services	✓							Accounts package: (floorspace, site services, telephones, site administration, maintenance) × manufacturing efficiency
				Floor space, etc. for rework	✓			Accounts package: (floorspace, site services, telephones, site administration, maintenance) × (1 – manufacturing efficiency)
Materials and methods Purchased material and material handling and packing	✓							Cost estimates
				Scrap, contingencies material price variance	✓			Scrap report
Task allocation, supervision of process, progressing (NOTE. Processing information provided by Industrial Engineering	✓							Accounts package: (supervision, progress labour costs) × y %[a]
				Fault finding guides, cost of change, implementation, on the job training	✓			Accounts package: (supervision, progress labour costs) × (1 – y) %[a]
Total process conformance cost				Total process nonconformance cost				
Prepared by								
NOTE See Figure 4 and Table 2.								
[a] y is the agreed proportion of the costs being considered.								

Figure 7 — Typical cost report for a manufacturing department

PROCESS COST REPORT								
PROCESS Quality Assurance			**PROCESS OWNER** Q.A. Manager			**DATE**		
Process conformance	**Cost**			**Process nonconformance**	**Cost**			**Cost data source**
	Act.	**Syn.**	**£**		**Act.**	**Syn.**	**£**	
Internal scheduled audits	✓			Internal non-scheduled audits	✓			Recorded time
				Follow-up actions and audits	✓			Recorded time
Appraisal of prospective supplies	✓							Recorded time and expense
Scheduled surveillance and audit of supplies and subcontractors	✓			Additional surveillance and auditing the result of poor product of service	✓			Recorded time and expense
Production, control and maintenance of quality plans, manually and procedures				Revisions and reissues to correct errors and omissions	✓			Recorded time and additional cost of reprographics
				Investigations and trouble shooting	✓			Time recorded
Agreeing and monitoring standards, plans, milestones, etc.	✓			Follow-up actions replanning, complaints rejects, etc.	✓			Time recorded and expense
Total process conformance cost				Total process nonconformance cost				
Prepared by				Signed			Approved	
NOTE 1 Cost of labour and material only would be considered unless drastic improvements lead to reduction of facilities. NOTE 2 See Figure 4 and Table 3 for models of process and cost.								

Figure 8 — Typical process cost report for a quality assurance department

PROCESS COST REPORT

PROCESS Preparation and printing of technical publications **PROCESS OWNER** Technical Publications Manager **DATE**

Process conformance	Cost			Process nonconformance	Cost			Cost data source
	Act.	Syn.	£		Act.	Syn.	£	
Appraisal of client's requirements		✓		Reappraisal due to change of brief		✓		Time and heavy rate Time sheet coded booking
Log-in client input data, sort and store		✓						Sub-divided by reference to typical activity surveys and presented as synthetic cost
				Queries on input data and action to address anomalies		✓		
Author's initial draft	✓							Time and heavy rate Time sheet coded booking
Preparation of illustrations and graphics	✓							Time sheet coded booking
In-house technical and editorial approval of draft	✓							Time sheet coded booking
Correlate and ratify in-house comments, change text and illustrations, update master on publishing system and publish first draft for client, comment/approval	✓			Rework due to in-house policy changes	✓			Time sheet coded bookings
Incorporate minor additional and technical comments from client and reissue. Reissue for approval	✓			Rework due to adverse comments from client relating to compliance with contractual requirements	✓			Time sheet coded bookings
Print and issue final publication		✓						Synthetic cost derived from typical activity surveys
Computer terminal/word processor Electronic publishing system	✓							Depreciation and maintenance costs recharged
Filler spray booth Photocopier	✓							Computer use recharged to Technical Publications Unit
First print run of illustrations and artwork	✓			Cost of reprinting due to unsatisfactory work	✓			Reprographic Unit job sheets
Print text and incorporate printed illustrations, assemble and bind at "draft for in-house approval" stage	✓			Cost of reprinting illustrations and artwork due to in-house policy changes	✓			Reprographic Unit job sheets
Print, assemble and bind at "draft for client approval" stage	✓							Reprographic Unit job sheet
Print, assemble and bind at final publication	✓							Reprographic Unit job sheet
Total process conformance cost				Total process nonconformance cost				

Prepared by ..... Signed ..... Approved .....

NOTE See Figure 5 and Table 4.

Figure 9 — Typical process cost report for a technical publications unit

Appendix D Preparation of process and cost models

NOTE From the process model shown in Figure 10 and the cost model given in Table 5, a process cost report (see appendix C) can be developed to suit the requirement of the process.

D.1 Preparation of process model stages 1 to 4

Figure 10 shows stages 1 to 4 in the preparation of a typical process model for the provision of food services to the National Health Service.

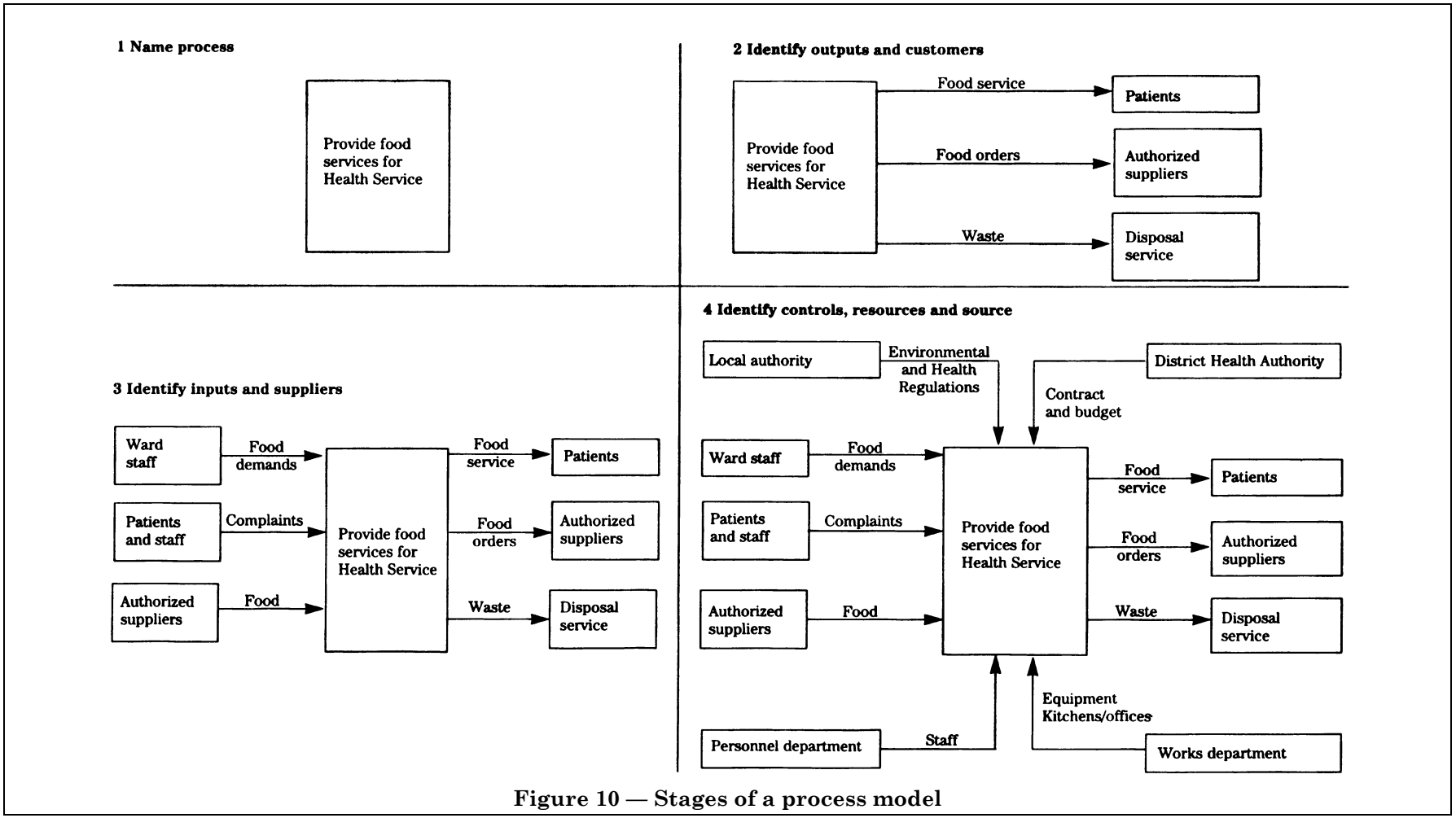

Figure 10 — Stages of a process model

D.2 Identification of costs for key activities

Table 5 gives an example of the preparation of a cost model for the provision of services to the National Health Service.

Table 5 — Identification of costs for key activities

Key activity	Process costs related to providing food services	
	Cost of conformance	Cost of nonconformance
Plan and order food	Cost of labour to produce accurate plan and to order correctly	Cost of waste food due to over planning Cost of supplying expensive alternatives due to under planning
Prepare and present food	Material, labour and energy costs to produce planned food	Cost of waste food and labour, etc. due to incorrect preparation and packing
Deliver food	Cost of delivery to patients within specified times	Cost of waste due to delays or incorrect deliveries
Handle complaints		Cost of investigations and rectifications
Clean facilities	Cost of materials and labour to clean to specified standards	Recleaning costs Cost of prohibition/improvement notices
Train staff	Cost of planned training	Cost of cancellations Cost of ineffective training

Publication(s) referred to

BS 4778, *Quality vocabulary.*
BS 4891, *A guide to quality assurance.*
BS 6143, *Guide to the economics of quality.*
BS 6143-2, *Prevention, appraisal and failure model.*

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