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Confidence in quality — customers' and company, Part II

Summary

In the previous issue, Part I of this article discussed the concepts of product quality and quality confidence. It stressed the importance both to the customer and the company of quality being built in to a product from the start.

Part II continues the discussion with the importance of ensuring quality confidence in the procurement of bought-out items, the necessity of maintaining close scrutiny throughout manufacture and that, during installation and commissioning, the same high standards are continued. The article is concluded by a definition of what is implied by effective quality management.

Quality in procurement

Some 50 per cent of the direct cost of an equipment in the factory can typically be represented by purchased items and materials. To get adequate 'quality confidence' in this is obviously of paramount importance. Procurement activities can cover complete systems down to electronic components and raw materials. Three elements can particularly be identified as being essential to good procurement.

(1) The availability of adequate specifications defining exactly what is required.
(2) The identification of satisfactory suppliers.
(3) The establishment of adequate confidence that the items supplied will be in accordance with the required specifications.

The provision of adequate specifications has already been covered in the preceding section, for the designer is responsible for choosing the right things to buy. The identification of satisfactory suppliers is usually a joint exercise between the designer and procurement personnel. In the case of new requirements or the need for procurement from a supplier not previously or recently used, a supplier evaluation exercise is, if thought necessary, carried out. Here, the supplier is visited and his ability to supply items of the type required assessed, and his 'quality management' system examined to determine that he can meet and continue to meet the requirements specified. The compiling of component specifications and the choice of supplier can well be activities of an iterative nature involving the supply of sample components and the testing of these in the equipment or a simulation rig. Where there has been experience of the supplier, records of his performance will have been continuously maintained and the appropriate quality rating allocated. This can be used in taking decisions regarding fresh orders.

Together with the above, the selection of a particular supplier will also involve considerations of the level and type of on-receipt verification, and these will depend on the assessment or quality rating of the supplier. In the case of supplies of complex items or sub-systems, direct verification is usually required, and a decision needs to be taken whether to perform this on receipt or at the supplier's premises before despatch.

Quality in the factory

A formal interest in 'quality confidence' has been in evidence in factories for many years, having passed through the earlier 'inspection' phase in which rigorous sieving out of defects took place, to the broader modern quality management concepts which seek additionally to minimize the creation of defects in the first place.

However, verification of conformity is still a central theme in factory quality considerations. Requirements are placed on the factory from appropriate areas of the company, these being in the form of initial order documents together with the drawings, specifications, schedules, etc. As well as these explicit instructions, there will also be the implicit acceptance of the factory's practices, procedures and customs.

Planning is the key to successful factory operation, and the degree and competence of this has a direct effect on the 'quality confidence' of the final product. A complex equipment is made up of thousands of individually manufactured parts and purchased components, and the planning area has the responsibility to

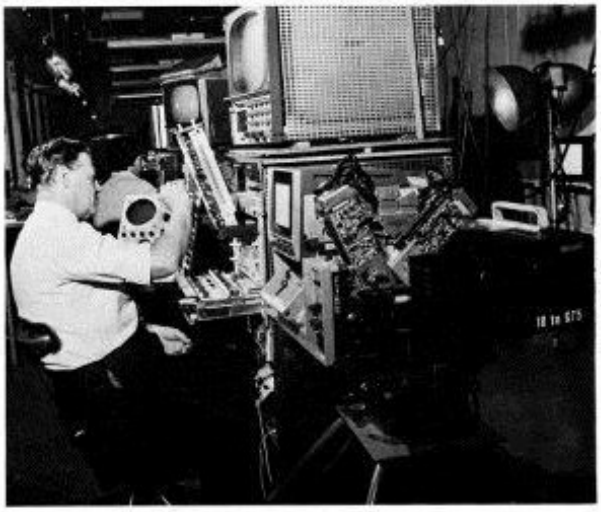

Figure 1. Mark VIII cameras undergoing final test

break down the initial order requirement to obtain the detailed specifications of piece parts and the types of manufacturing operation involved. Paperwork is generated giving explicit instructions for the detailed operations, together with destination information, and the completed piece parts are then forwarded to the next stage of manufacture. Requests are also generated for the purchase or allocation from stock of all components and materials. Time planning is vital to ensure that the correct manufactured parts and components are all available at the correct times to enable the various stages of assembly to take place without either delay or unduly high work-in-progress investment.

Appropriate verification is carried out during manufacture and is recorded to provide evidence that all necessary stage by stage verification has in fact taken place. Such evidence either passes forward to later stages of manufacture or, as appropriate, is used to provide a 'permit' to allow further stages of manufacture to take place. These in turn would then be verified and new evidence recorded. Thus, there is in operation a 'Pyramid of Proof' system whereby verification at many earlier stages allows progress to the later but fewer stages of manufacture and assembly, culminating in the evidence that the final equipment meets its overall requirements.

Process-type operations, e.g plating, painting, etc. are covered by process specifications. These define the end-product requirement, and also detail how the factory will achieve the required end result. They also define quality confidence criteria. In some complex processes such as the manufacture of printed wiring boards, it is necessary to establish and maintain detailed control of the many processes that are involved. Quality activities in such circumstances are not limited to straightforward verification at appropriate stages, but will also include checks on the process itself, e.g chemical constitution of electrolytes, temperature of baths, dwell times, etc. Routine checks of certain parameters may need to be made on test samples regularly passed through the system. Widely used factory operations which can have a significant effect on product quality are the subject of documented workshop practices. These define in adequate detail how certain operations are to be carried out, including the method to be used and any particular physical aides of tools required.

The existence of a disciplined system of work instructions and controls enables the inevitable need for design changes to be adequately controlled. Such changes can arise from a change in contract requirement or from the realization that existing instructions are incorrect or inadequate. Drawings and specifications issued by the designer form mandatory instructions on the factory and can only be changed by the designer. In special circumstances there may need to be a departure from such instructions, but this is always formally agreed with the designer, and such agreement will only apply to the particular order under consideration.

In the later stages of manufacture, verification will not only be provided by mechanical inspection, but also by appropriate electrical testing. Such testing takes place in a test area by specially qualified personnel to the production test specification. Further assembly may then follow in stages with further testing until the final product is tested against its test specification.

In some cases the use of automatic test equipment may be economical. Here there is a vital need for the designer and the specialists in automatic testing to liaise closely. The designer will need to provide adequate access points for the connection of the automatic test equipment. The appropriate test specification will originally be prepared in written form, but will need to be converted into a form, such as on tape, to be suitable for the automatic equipment. When such a tape has been prepared and proved, it then becomes a part of the design documentation and will have the same disciplines concerning change control that will apply to a more conventional specification.

Having completed the assembly and the verification in conformity with the production-test specification, the test area is usually responsible for carrying out any customer-acceptance tests, and providing any contractually required quality verification documentation.

Throughout the manufacturing processes, measurements are being made to establish conformity with drawings and specifications. These measurements involve the use of appropriate instruments of varying sophistication from foot rules to complex electronic system analyzers costing many thousands of pounds. For all such measurements it is essential to establish the permissible level of uncertainty, and then to acquire confidence that the instrumentation used will provide this. Thus there exist electrical and mechanical calibration areas and control systems to ensure that all measuring equipment concerned with establishing conformity is calibrated at adequate intervals. The calibration area has a standards room with standards whose calibration is traceable to national or international standards. In certain cases it may not be cost effective to maintain a calibration facility for some particular parameter.

Arrangements exist for such re-calibration work to be carried out by an appropriate outside service who, in turn, can provide the necessary traceability and have approval as a calibration facility.

Quality in installation and commissioning

Installation and commissioning present certain particular quality problems. By their very nature these activities take place in areas distant from the more easily controlled environments of design laboratories and factories. Equally, the facilities available are in general less complex and all-embracing.

Depending on the complexity of the system and the anticipated siting difficulties, an engineer may visit the proposed site, in advance of work being commenced, to carry out a site survey. A system designer is responsible for the overall design of the installation, but the layout

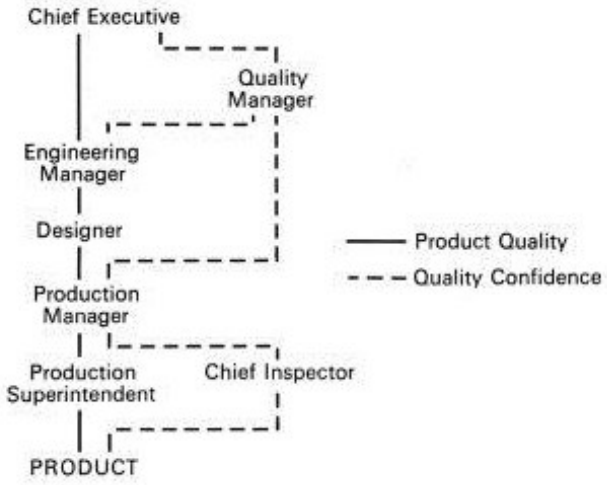

Figure 2a. Organization chart of a model company

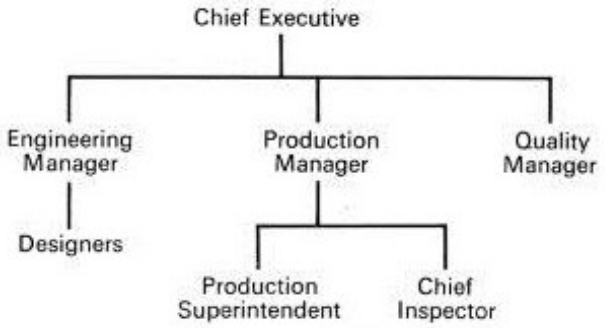

Figure 2b. Quality responsibility chain

design is usually delegated to an installation design office which specializes in this activity and thereby has acquired considerable experience of the sometimes peculiar installation requirements. The installation design office prepares instructions indicating the required disposition of the various items of equipment and their electrical and mechanical inter-relationships. The actual task of installation is carried out by specialist engineers. As in the factory, it is necessary to verify the performance of the work done both to the drawings and to accepted work standards. On large sites inspectors will be used for this purpose, but on small sites it is often necessary to use the installation engineers in this role. In such cases, care is taken to establish a degree of separation and independence between the doing of the work and the verification thereof. Depending on the detail of the contract, verification activities may need to be overseen by the customer's representative.

Some operations carried out need an element of process control, e.g wire wrapping and crimping, and the tools used therein may need certification and checks made to see that the process is being carried out correctly.

As in the factory, it is necessary to have confidence in the degree of uncertainty of measurements made, and usually test equipment is calibrated before being sent to site. If the installation goes on for a long period, it is necessary to make special arrangements for checking the calibration of the test equipment to ensure an adequate uncertainty level is maintained.

Requirements for effective quality management

As stated at the beginning, 'quality management' covers the management actions to ensure that the required 'product quality' and 'quality confidence' will be achieved. One of the most important needs is to define responsibilities for all activities, and ensure that these are understood and accepted. It is essential to have responsibilities defined rather in the following terms:

(1) Who is responsible for what?
(2) Who is he responsible to for this?
(3) How is the responsibility discharged?

And as an essential corollary to the above:

(4) How do we know that he has done it or is continuing to do it?

Such responsibilities need defining both for 'product quality' and 'quality confidence'. In any business organization all responsibilities and authorities ultimately derive from the chief executive (e.g managing director, general manager, etc.) of the organization, and it is important that all quality responsibility chains are traceable back to him. Figure 2a shows as an example a much simplified administrative organization chart of a

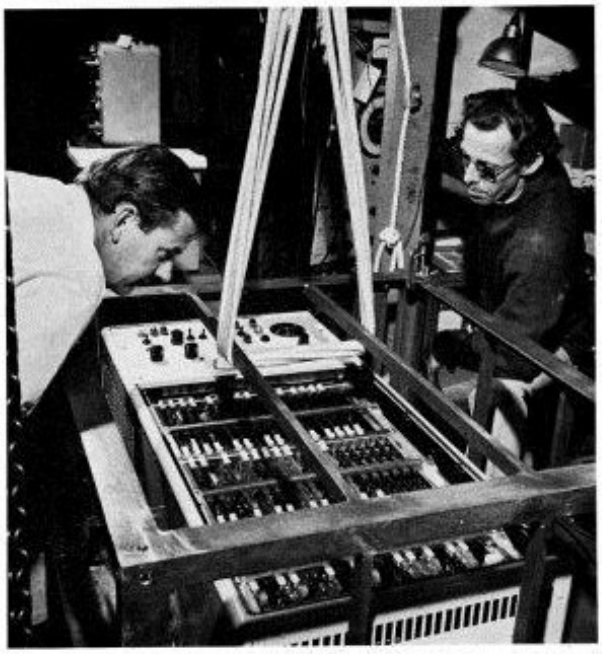

Figure 3. Marconi underwater sonar equipment being subjected to environmental testing

company selling equipment of its own design and manufacture. (A real-life company such as MCSL is by nature more complex, but the principles listed here still apply.) Figure 2b shows this organization chart redrawn to show the 'product quality' and 'product confidence' chains, and how they lead back to the chief executive. 'Product quality' will be via the engineering manager, since this is defined in the design process. His designer carries out the design process and issues instructions (the drawings and specifications) to the production manager who, via his production superintendent, and his operatives, manufactures the product. 'Quality confidence' is the responsibility of the quality manager who also reports to the chief executive thereby having an independence from all quality achievement activities. He, on the one hand, is concerned with the design process, and on the other with the production. He would normally delegate this latter responsibility to the production manager. This responsibility is discharged for the latter by the chief inspector. Even in this simple case it will be seen that the quality chains appear to be rather long. On a day-to-day basis, lateral communications at lower levels in the real, more complex organization are essential, but these are based on the delegation from higher authority with mechanisms for reference upwards if problems are not soluble at the particular level.

'Quality confidence' actions are concerned with the establishment of, and monitoring the effectiveness of, quality procedure on the one hand and the verification of conformity of the product with its specification on the other. The preceding sections have indicated the nature of many of these actions in the various areas. It is a basic responsibility of the quality manager to recommend and set up overall quality policies that will ensure that such actions occur in a timely fashion.

The formal statement of the responsibilities and the quality policies and procedures is the basis of a company quality manual. This acts as a guidance and control document for the quality aspects of the organization and as a reference to enable the quality performance to be audited by management; for auditing does for quality organization what verification does for product quality. This auditing is carried out by quality staff, and to be effective it is planned, both as to the content and the frequency thereof. Such planning is flexible, however; an organization undergoing change or experiencing problems needing perhaps more frequent auditing in greater depth. Audits are arranged in co-operation with the line manager of the unit being audited, and the results of the audit and any necessary corrective actions are discussed with him.

Follow-up audits are necessary to ensure that agreed actions are carried out.

The second function of a quality manual is to provide information to give confidence to prospective customers. As mentioned at the beginning of this article, a potential customer may wish to evaluate the company before placing a contract, and the quality manual can play an important part in this context.

Conclusion

The foregoing attempts to indicate some of the aspects of 'quality' that arise in an electronics company and the activity for taking care of these. Such activities can be considerable in extent and cost money. An experienced electronics company has its own view, based on the type of product and market, of an adequate normal level of 'quality confidence' activities, this being defined in its quality manual and reflected in its price levels. Where a customer needs a higher confidence level, the extra activities and the costs thereof need to be negotiated before the placing of a contract. He needs to balance the cost of such special requirements against the cost of the 'quality' failures that might ensue if these requirements are not met. By the same token, he needs to balance the saving in first cost that may result from dealing with a firm whose normal 'quality confidence' activity is at a much lower level against the likely higher costs of subsequent 'quality' failures.