

Organising Quality Function in Research and Development

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ABSTRACT

Quality function may be summarised as quality generation, quality control, and quality assurance. The quality generation and quality control, because of their functional nature, are comparatively easy to organise, however, the challenge is to organise quality assurance in the organisation. It is the challenge because quality assurance should seamlessly merge with the R&D process. In future, the organisations, whether real or virtual, are going to be predominantly, research and development (R&D) oriented rather than pure manufacturing or service providers. However, the nature and intensity of the R&D may differ. It could be from simple improvement to innovation, to exploitation of inventions.

Organising quality function in R&D means organising its various dimensions against the stipulated criteria such as the realisation of the quality system; realisation of quality during product development, including system engineering; staffing of quality generation, quality control, and quality assurance; balancing of the quality function; harnessing of project quality, functional quality, staff quality and line quality; application of the RHR principle; exploitation of the tools of organising, democratic organisation; and so on. The basic purpose of organising the quality function is to inculcate the sense of pride in quality among the scientists so that they feel passionate about it. It is the passion and love for quality that generates, sustains, and maintains quality.

Keywords: Quality function, research and development, turbo quality system, organising criteria, line quality, staff quality, functional quality, project quality

1. INTRODUCTION

Quality function is one of the cardinal functions in any organisation. It determines and sustains the brand equity of the organisation. It is spread throughout the organisation. Lately, the leaders in research and development, worldwide, have evinced great interest in understanding how the quality function should be organised in R&D. This paper is based on the experience at the Research Centre Imarat (RCI), Hyderabad, and evolves how the quality function should be organised in R&D.

Before delving on how the quality function should be organised in R&D, the paper brings out what is the quality function? Why is it increasingly becoming important in R&D? Why is the distinction between manufacturing and R&D constantly getting blurred? What is to be organised regarding quality function? How the quality function should be organised in R&D?

2. QUALITY FUNCTION

According to ISO 9000:2000, quality is the ability of a set of inherent characteristics of a product,

system, or process to fulfil the requirements of customers and other interested parties. According to the author, quality is paxonistic experience with zero risk and vulnerability. There is no contradiction between the two definitions. The ISO 9000:2000 definition, is only the subset of the author's definition and further, the ISO 9000:2000 defintion may get upgraded, but the author's definition is likely to remain as a benchmark.

Keeping both the definitions in view, quality function may be depicted as in Fig. 1. As suggested in Fig.1, the quality function may be summarised as quality generation, quality control, and quality assurance. It may be taken axiomatically, that quality function is best realised if it is in the hands of those having quality system, test and evaluation (T&E), and design review capability. The quality generation and quality control, because of their functional nature, are comparatively easy to organise, however, the challenge is to organise quality assurance in the organisation. It is the challenge because quality assurance should seamlessly merge with the R&D process.

Quality function is realised in the organisation through the quality system such as ISO 9000, SPICE, turbo or lean quality system, etc. In R&D, the turbo or lean quality system would be more appropriate. It is the rapid quality system consisting of the following elements :

- a) Quality plan
- b) Requirements review
- c) Design review
- d) Qualification testing/acceptance testing(QT/AT)
- e) Procurement quality information
- f) Quality audit
- g) Documentation.

For organising quality function, the various types of quality may be defined as follows:

- Line quality is the quality which is already established in the product or the system made in the line.
- Project quality is at least the minimum quality which makes the project successful. It helps in rapidly proving the product or the system and, subsequently, it can be upgraded into the line quality. It is the result of the rapid quality typing, like rapid prototyping.
- Functional quality is the quality which generates the project quality and, subsequently the line quality.
- Staff quality is the critical quality which assists in generating the project quality and, subsequently the line quality.

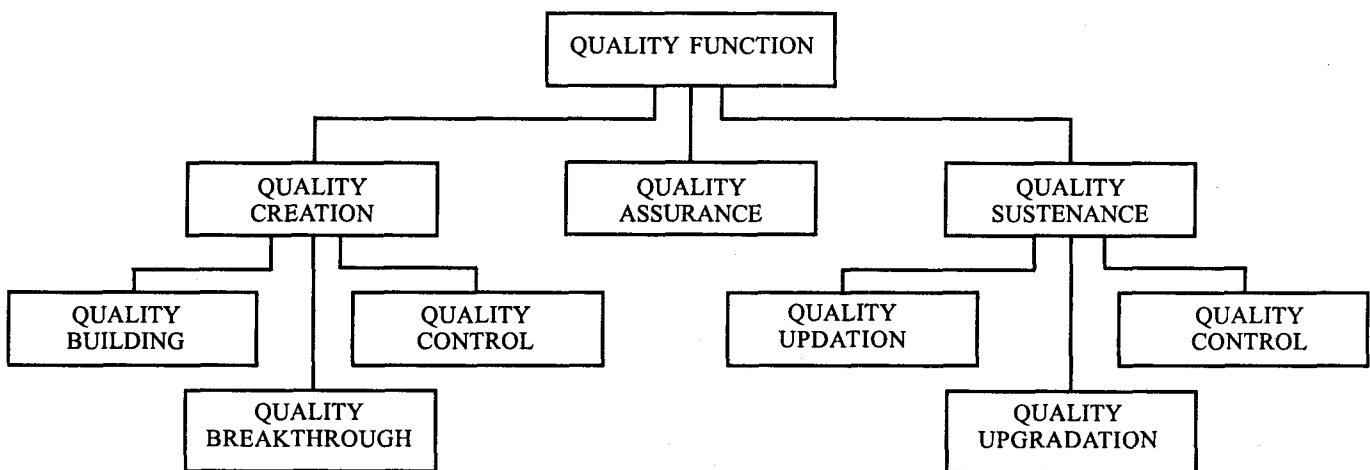


Figure 1. Quality function in research and development

3. RESEARCH & DEVELOPMENT

Custom-built systems, lower cycle time for system realisation, and faster obsolescence, are the forces which may gradually phase out the production systems in the traditional sense. What is expected to evolve, instead, is the R&D system which caters to the needs of the various context-holders. The R&D systems would produce a large number of similar systems, which could be differentiated from one another. In essence, it would mean that the routine jobs would be on the decrease; knowledge workers would be on the increase; this would lead to the decrease in the executives/workers ratio. In fact, there would be only different types of knowledge workers. The entire workforce, from the top management to the lowest-level worker, would have to continuously think in terms of innovation (innovation+improvement). Hence, the work environment would, predominantly be of the R&D type: The degree and intensity of R&D would only differ.

Generally, R&D consists of the following:

- *Basic Research* : Research projects that represent original investigations for the advancement of scientific knowledge and that do not have the specific customer in mind.
- *Applied Research*: Research projects that represent investigation directed to the discovery of new scientific knowledge with a specific customer in the mind.
- *Development*: Technical activities concerned with the non-routine problems that are encountered in translating research findings or other general scientific knowledge into the products or the processes. This includes innovations and improvements, in short, innovation. The majority of R&D is covered under this head.

For lower cycle time, for system realisation and for combating obsolescence, the R&D can be best organised as projects. In future, the organisations, whether real or virtual, are going to be predominantly, R&D in nature rather than pure manufacturing or service providers. However, the nature and intensity of R&D may differ. It could be simple improvement to innovation, to exploitation of inventions.

4. TOOLS OF ORGANISING

Organising refers to the process of bringing together physical, financial, and human resources, and establishing productive relations among them for the achievement of specific goals and for achieving human satisfaction. The aim of organising is to enable people to relate to each other and to work together for a common purpose and for human satisfaction, ie, job satisfaction (which relates to the individual) and high morale (which reflects the feelings of the group).

Organising is the establishment of authority relationship with the provision for coordination between them, both vertically and horizontally in the enterprise/organisational structure. Organising as the process involves division of work (for facilitation of specialisation of efforts and skills), grouping jobs and departmentation (for facilitation of unity of effort and linking of work units based on their interdependence), and establishing graded authority and responsibility relationships.

The organised group of people in a collective sense is known as organisation. The three basic elements because of which an organisation comes into being are:

- (a) The individuals who are able to communicate with one another
- (b) The individuals who are willing to act
- (c) The individuals willing to accomplish a common purpose.

Communication is the foundation through which the organisation achieves its goals. Communication serves not only to transfer information and to help understanding among individuals and groups, but it also unifies group behaviour. Unified group behaviour provides the basis for continuous group cooperation.

5. FORMAL & INFORMAL ORGANISATIONS

The organisation structure designed and established by the management is called the formal organisation. It is officially setup to achieve certain goals, It is a system of well-defined activities and relationship,

which are intended to divide and integrate the activities of the organisation. Within the formal organisation, members undertake the assigned duties in cooperation with each other. They interact or communicate among themselves in the course of their work. Gradually, they develop friendly relations and form small social groups. The network of these social groups based on friendship is called the informal organisation. Informal groups are formed on the basis of common interests. The informal organisation is thus a system of social relationship among the members. It emerges on its own within the formal organisation.

The informal organisation is a part of the formal organisation; it cannot be separated. In other words, a single organisation has two facets—the formal, and the informal. These are two aspects of the same organisation and are linked to each other. An organisation is neither totally formal nor totally informal. It is a combination of these two aspects. In the formal organisation, members are required to use official lines of communication which are based on authority and responsibility. Members interact with each other on the basis of their levels of authority and job positions. The directions and flow of communication are fixed and predetermined. Members of an informal organisation, develop their own channels of communication for interaction with each other. The channels of communication in the informal organisations are often compared to a 'grape-vine'.

5.1 Line Organisation

The line organisation directly takes the responsibility for the main activities of the organisation. In this, all managers have direct authority over their respective subordinates, through the chain of command. For example, if the quality manager has the direct responsibility for installation, implementation, and sustenance of the turbo or lean quality system in R&D, then he is in the cast of line function.

5.2 Line & Staff Organisation

The line and staff organisation refers to an organisation in which two types of authority relationships co-exist. These are direct or line authority, and

advisory or consulting authority. The advisory or consulting authority relationships are known as staff relationships. Staff authority means authority to advise, to support, and to serve.

In a line and staff organisation, most managers continue to have line authority to decide and do things as in the line organisation. However, a few general and specialised staff positions are created for advisory, administrative, and supportive functions. Staff positions have better communication across the line and functions, and also better motivation for communication because their success is dependent upon marketing their ideas to others. For example, quality walkthrough, special quality assessment, internal quality audit, and so on, of the quality system or product in an organisation is a staff function.

5.3 Functional Organisation

The functional organisation is defined as an organisation in which the line authority, staff authority and a third type of authority known as functional authority (a limited form of line authority over certain specialised activities), exist together. Managers who are given functional authority have the right to issue directives on matters over which they do not have direct line authority otherwise. For example, the quality manager, is a staff expert and has advisory staff authority in the line and staff organisation; but in the functional organisation, he may be given a limited line authority to ensure that quality policies are observed in all the departments throughout the organisation.

The functional authority of the quality manager is similar to the line authority of the line managers but is restricted to some specialised activities only, such as requirements review, detailed design review, printed circuit board (PCB) layout review, derating analysis, screening of parts, reliability analysis, overview of environmental stress screening (ESS), overview of qualification and acceptance testing, code walkthrough, blackbox and whitebox testing, independent verification & validation (I&VV), analysis of test results, quality improvements, logic analysis and review, syntax and semantic analysis and review, timing analysis and review, margins analysis and review, quality

assessment, test article review board (TARB), failure analysis board (FAB), waiver, facility review, procurement quality information review, document development and review, design certification, development of standards, vendor development, vendor assessment, benchmarking, development of quality policies, design of templates for quality system documents, training in gap areas, development of training schools/institutes, and so on.

The functional organisation is a more complex type of organisation than both the line and staff organisation and line organisation. In this, three types of authority relationships co-exist. These are line authority relationships, staff authority relationships, and functional authority relationships. The principle of unity of command does not apply to this form of the organisation. Managers and other subordinates get instructions from more than one superior. In this, more importance is given to the staff specialists. In addition to staff authority, they are also entrusted with the authority to decide and do things, although in a limited way.

Functional organisation provides specialisation (which improves efficiency), flexibility (without disturbing the whole work), and democratic control (which helps, each person grow in his own specialty). However, it has some of the drawbacks speciality as, conflict in authority (the principle of unity of command is violated), complicated coordination, delay in taking decisions (but better decisions are obtained), expensive (because a large number of experts are involved), group rivalries, etc.

5.4 Committee or Task or Board Organisation

A committee or a board or a task group is a group of people, usually of same authoritative level, which work collectively, discuss, decide, and recommend solutions to the problems assigned to them. It consists of a group of people conversant with the subject. Naturally, their advice will be much better than that of a single scientist. Multifaceted problems, too big and too complex, to be dealt effectively by one scientist, are dealt by the committees. The number of persons in the committee depends upon the need, objectives, and responsibilities. The authority

of the committee should be clearly defined. Committee may be a standing or permanent committee, temporary committee, coordination committee, advisory committee, and so on. For example, a committee may be constituted with quality chief on the chair for review of a facility or for creation of a new facility; similarly, standing committees for design review, failure analysis, waiver/deviation, test article review, QT/AT document review, etc may be constituted.

5.5 Project Organisation

The project is a one-time task with well-defined specifications. It is a set of end-to-end activities for the development and realisation of the product or the system. The project organisation structure is most suitable to enterprises, which are engaged in time-bound activities. When an already existing organisation finds it difficult to cope up with the new situations, it may decide to launch a project organisation. To accomplish the project goals, a separate project is created for each case. Project organisation is created when the project is big in size and subject to high standards of performance. A project organisation is solely responsive to the planning, design, development, production, evaluation, quality, time, cost and support of a single system or product. It provides the line function for the system or the product during the currency of the project. For example, a project director may be assigned to a project who is solely responsible for the end-to-end realisation of a system or a product, but he may appoint director (quality) for realising project quality as a project function.

5.6 Matrix Organisation

A matrix organisation is a wonderful mix of functional organisation and project organisation. Matrix organisation is constituted when one organisation has to handle a variety of projects, ranging from small to large. The project structure provides a horizontal dimension to the traditional vertical orientation of the functional organisation. During the currency of the project, each person has two bosses—one from the functional department and the other of the concerned project. In a matrix organisation, the resources and the specialists are optimally

utilised. However, in this type of organisation, authority structure may be broken and may lead to strained relationships, thus, calling for superior tactful handling and better understanding among the seniors. This type of structure, if tactfully deployed, may lead to better human satisfaction for quality assurance function and better realisation of quality function.

6. WHAT IS TO BE ORGANISED?

6.1 Activities to be Organised

- Quality function in its various dimensions—quality generation, quality control, and quality assurance.
- Development of the quality system, domain design review, and test and evaluation capability among the leaders of the quality function.
- Installation, operation, sustenance, and maintenance of the quality system in the organisation.
- Installation, operation, sustenance, and maintenance of the quality system for the product or the system to be developed.
- Installation, operation, sustenance, and maintenance of the quality system for the projects.
- Advisory or consultation tasks for furthering the quality function and/or quality system.

6.2 How to Organise?

Criteria for Organising

- *Implementation of the Quality System:* Quality, as evolved and approved by the top management, should be implemented. It could be based on ISO 9000, IS16000, ISO15504, ISO17025, etc or it could be turbo or lean quality system, or any other evolved quality system.
- *Realisation of Quality during Product Development, including System Engineering:* It consists of organising for quality system for the product, including system engineering.
- *Staffing of Quality Generation, Quality Control and Quality Assurance:* Quality

generation, quality control and quality assurance should be staffed with design, test and evaluation, and design review capability, respectively and the leaders should have design review, test and evaluation, infrastructure, and human resource development capability.

- *Balancing of the Quality Function:* Quality generation, quality control, and quality assurance should be evenly and delicately balanced, in spite of uneven distribution of resources.
- *Application of RHR Principle:* The RHR principal states that the necessary and sufficient condition for electrified, efficient and effective manpower is the balanced RHR. In the RHR principal, R, H, and R stand for the following:

(R) *Rich in Content*-Richness in the content of work is relative. It is directly related to the reward and award (R&A) system. Content which is rewarded/ awarded becomes rich.

(H) *Hompetence (Homeostasis + Competence)*-Self-motivated manpower electrifies the workplace. Hompetent manpower can make the content rich and can also spin the reward and award (R&A) system.

(R) *Reward and Award System*-Reward and award (R&A) system can make the dull content, rich and convert fresh manpower first into competent and then into hompetent manpower.

Role of Leadership-Leadership harnesses RHR principle for creating conducive and effective environment.

- *Harnessing of Project Quality, Functional Quality, Staff and Line Quality:*

Project Quality-A project has exacting influence on quality, cost and delivery. In this sense of urgency, at least minimum quality should be assured so that the project objectives are met.

Line Quality-It is the established quality in the line.

Functional Quality-It is the quality obtained by functional responsibility in the project or

line organisation. It contributes both towards project quality and line quality.

Staff Quality—It is the quality of critical functions obtained by staff in the project or line organisation. It contributes both towards project quality and line quality.

- *Director (Quality) for Organisation/Each Project*: Organising for quality system for the product, including system engineering can best be done by appointing a dedicated director (quality) for organisation/each project.
- *Exploitation of the Tools of Organising*:

Line & Staff Organising—Main tasks of quality are done through line organisation and advisory and consulting quality tasks through staff organisation. Further, line tasks are functionally organised, each function contributing towards line quality.

Functional Organising—In functional organising, besides line and staff organising, there are functional groups handling specific quality tasks.

Project Organising—Project organising is a line and staff organisation for project quality.

Matrix Organising—Matrix organising is organising with multi-projects/lines which form network with functional and staff groups based on as required basis for project/line quality.

Committee Organising—Committees or task teams are formed for a specific task-standing or otherwise – for staff or functional quality.

Formal Organising—Formal organising is the organising as promulgated by the top management for achieving the quality objectives.

Informal Organising—Within the formal organisation, members undertake the assigned duties in cooperation among them. Gradually, they develop friendly relations and form small social groups. The network of these social groups based on friendship is the informal

organisation. Informal groups are formed on the basis of common interest. It emerges on its own in a natural manner within the formal organisation. Many a times, informal organisation helps greatly for meeting the quality objectives.

Democratic Organisation: An organisation with participative paradigm is the fertile ground for quality ideas, inovement, and quality realisation.

7. ORGANISING IN R&D

Quality of the organisation, user, system, and allied developers is the quality of the people. Development of the quality people and their quality management is axiomatically assumed, as it being the top management domain.

Quality of a system (weapon system in this context) is the quality of the requirements (eg, qualitative/requirements) and their sponsorship by the user (eg, customer or client). This may be achieved by the committee of the stakeholders. This committee is an apex standing committee and may deal with only system-level requirements, their review, and broad configuration issues.

Quality and quality assurance of the design and development of the system is the result of the quality of its system engineering. This may be achieved by the committee of the domain designers and developers, including reliability and quality assurance (R&QA), and test and evaluation. This committee is a standing committee and may deal with only system-level design, development of subsystem requirements and their interfaces, and detailed configuration issues.

Quality and quality assurance of design and development of the subsystems is the result of the quality of their domain knowledge. This may be achieved by the functional organising of the subsystem. This gives functional quality which contributes towards project quality or line quality.

Quality control of the system and the subsystems is the result of their domain and quality systems, knowledge. This may be achieved by the functional organising.

Quality assurance of the system and the subsystems is the result of their domain, test and evaluation (T&E), and quality system knowledge of the organisation. This may be achieved by the staff and functional organising.

Project quality may be realised through project organising and by appointing director (quality), for the project. Director (quality) may implement, at least, turbo quality system.

Line quality may be realised through line organising and by appointing director (quality) for the line. Director (quality) may implement the quality system.

Quality system is the result of the domain, test and evaluation (T&E) and quality system knowledge of the organisation. This may be achieved through the staff and functional organising. A separate R&QA group may perform this function. The various elements of the quality system, such as facility review, procurement quality information review, document development and review, design certification, development of standards, vendor development, vendor assessment, requirements review, design review, failure analysis, waiver/deviation, test article review, QT/AT document review, etc, may be implemented through committee (standing or otherwise) organising.

The basic purpose of organising the quality function—quality generation, quality control, and quality assurance—is to inculcate the sense of pride for quality among scientists so that they feel passionate about it. It is the passion and love for quality that generates, sustains, and maintains quality. To keep this passion alive, the scientists, particularly quality assurance scientists, should be rotated through project, line, committee, staff, and functional organising.

8. CONCLUSIONS

Quality function may be summarised as quality generation, quality control, and quality assurance. The quality generation and quality control, because of their functional nature, are comparatively easy to organise, however, the challenge is to organise the quality assurance in the organisation. It is a

challenge because the quality assurance should seamlessly merge with the R&D process. Quality function is realised in the organisation through the quality system such as, ISO 9000, SPICE, turbo or lean quality system, or any other improvised quality system. In R&D, the turbo or lean quality system would be more appropriate.

Generally, the R&D consists of the basic research, applied research, and/or development. In the majority of cases, R&D is covered under the head of the development. In future, most of the organisations, whether real or virtual, are going to be, predominantly, R&D in nature, rather than pure manufacturing or service providers. However, the nature and intensity of R&D may differ. It could be simple improvement to innovation, to exploitation of inventions.

Organising quality function in R&D means organising its various dimensions against the stipulated criteria; development of the quality system, domain, design review, and test and evaluation (T&E) capability among the leaders of the quality function; installation, operation, sustenance, and maintenance of the quality system in the organisation for the products or the systems to be developed, and for the projects; and organising for the advisory or consulting tasks for furthering the quality function and/or quality system.

Criteria for organising consists of the realisation of the quality system; realisation of quality during product development, including system engineering; staffing of quality generation, quality control and quality assurance; balancing of the quality function; harnessing of project quality, functional quality, staff quality, and line quality; director (quality) for each project/organisation; application of the RHR principle; exploitation of the tools of organising; democratic organisation, and so on.

The basic purpose of organising the quality function is to inculcate the sense of pride for quality, among the scientists so that they feel passionate about it. To keep this passion alive, the scientists, particularly, quality assurance scientists, should be rotated through project, line, committee, staff and functional organising.

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