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Application of statistical and related methods to new technology and product development process —

Part 1: General principles and perspectives of Quality Function Deployment (QFD)

Application des méthodes statistiques et des méthodes liées aux nouvelles technologies et de développement de produit —

Partie 1: Principes généraux et perspectives de déploiement de la fonction qualité (QFD)

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 8, *Application of statistical and related methodology for new technology and product development*.

ISO 16355 consists of the following parts, under the general title *Application of statistical and related methods to new technology and product development process*:

— *Part 1: General Principle and Perspective of QFD Method*

The following parts are under preparation:

— *Part 2: Acquisition of Non-quantitative VOC or VOS*

— *Part 3: Acquisition of Quantitative VOC or VOS*

— *Part 4: Analysis of Non-Quantitative and Quantitative VOC/VOS*

— *Part 5: Solution Strategy*

— *Part 6: Optimization — Robust parameter design*

— *Part 7: Optimization — Tolerance design and output to manufacturing*

— *Part 8: Guidelines for commercialization and life cycle*

Introduction

Quality function deployment (QFD) is a method to assure customer or stakeholder satisfaction and value with new and existing products by designing in, from different levels and different perspectives, the requirements that are most important to the customer or stakeholder. These requirements should be well understood through the use of quantitative and non-quantitative tools and methods to improve confidence of the design and development phases that they are working on the right things. In addition to satisfaction with the product, QFD improves the process by which new products are developed.

Reported results of using QFD include improved customer satisfaction with products at time of launch, improved cross-functional communication, systematic and traceable design decisions, efficient use of resources, reduced rework, reduced time-to-market, lower life cycle cost, improved reputation of the organization among its customers or stakeholders.

ISO 16355 demonstrates the dynamic nature of a customer-driven approach. Since its inception in 1966, QFD has broadened and deepened its methods and tools to respond to the changing business conditions of QFD users, their management, their customers, and their products. Those who have used older QFD models will find these improvements make QFD easier and faster to use. The methods and tools shown and referenced in the standard represent decades of improvements to QFD; the list is neither exhaustive nor exclusive. Users should consider the applicable methods and tools as suggestions, not requirements.

ISO 16355 is descriptive and discusses current best practice but is not prescriptive by requiring specific tools and methods. Rather, applicable tools and methods are included in the Annexes to guide users of the standard.

ISO 16355-1 references the other seven parts of the Standard, as follows:

— *Part 2: Acquisition of Non-quantitative VOC or VOS* includes sections 8.1 - 8.2.7;

— *Part 3: Acquisition of Quantitative VOC or VOS* includes sections 8.2.8 - 8.2.9;

— *Part 4: Analysis of Non-Quantitative and Quantitative VOC/VOS* includes sections 8.2.10 - 11;

— *Part 5: Solution Strategy* includes sections 12 - 14;

— *Part 6: Optimization — Robust parameter design* includes section 15.1;

— *Part 7: Optimization — Tolerance design and output to manufacturing* includes sections 15.2 - 15.3;

— *Part 8: Guidelines for commercialization and life cycle* includes sections 16 - 24.

Application of statistical and related methods to new technology and product development process —

Part 1: General principles and perspectives of Quality Function Deployment (QFD)

1 Scope

This part of ISO 16355 describes the quality function deployment (QFD) process, its purpose, users, and tools. It is not a management system standard. It does not provide requirements or guidelines for organizations to develop and systematically manage their policies, processes, and procedures in order to achieve specific objectives.

Users of this part of ISO 16355 will include all organization functions necessary to assure customer satisfaction, including business planning, marketing, sales, research and development (R&D), engineering, information technology (IT), manufacturing, procurement, quality, production, service, packaging and logistics, support, testing, regulatory, and other phases in hardware, software, service, and system organizations.

2 Normative references

There are no normative references cited in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
quality function deployment
QFD
managing of all organizational functions and activities to assure product quality

Note 1 to entry: The organization is responsible for product quality and strives for it via defining, testing, building, commercializing, and supporting the product.

Note 2 to entry: Literal definition is that the “quality function” is “deployed” to all other business functions and departments who play a role in assuring quality and customer satisfaction.

3.2
voice of customer
VOC
communications from the customer

Note 1 to entry: The communications from the customer may be verbal, written, video, audio, animation, or other form and may be descriptive, behavioural, or ethnographic.

Note 2 to entry: *Customer* is defined in ISO 9000:2015, 3.2.4.

3.3
customer need
potential benefit to a customer

Note 1 to entry: The benefit to a customer from having their problem solved, their opportunity enabled, their image (self or to others) enhanced, or being advanced to a more desirable state.

Note 2 to entry: The benefit is positively stated.

Note 3 to entry: The benefit describes a single issue.

Note 4 to entry: The benefit is independent of the product or features.

Note 5 to entry: A need may be explicit or latent.

Note 6 to entry: *Customer* is defined in ISO 9000:2015, 3.2.4.

3.4
functional requirement
characteristic that a product or service is specified to possess

Note 1 to entry: The characteristic could be an inherent performance of the product or an action that the product shall be able to accomplish. The manner in which the product accomplishes the action should not include specific mechanisms or internal procedures is not part of the functional requirement.

Note 2 to entry: *Product* is defined in ISO 9000:2015, 3.7.6.

Note 3 to entry: *Service* is defined in ISO 9000:2015, 3.7.7.

3.5
voice of stakeholder
VOS
communications from the stakeholder

Note 1 to entry: The communications from the stakeholder may be verbal, written, video, audio, animation, or other form and may be descriptive, behavioral, or ethnographic.

Note 2 to entry: *Stakeholder* is defined in ISO 9000:2015, 3.2.3.

3.6
customer gemba
location where true information is found

Note 1 to entry: Gemba is a Japanese word meaning the place where the truth is discovered. In Six Sigma, this usually refers to the shop floor where internal activities take place. In QFD for new product development, the new product does not exist yet, so the gemba changes to where the customer's activities or encounters take place.

Note 2 to entry: There may be no physical location, i.e. for eCommerce or some processes.

Note 3 to entry: Gemba visits help discover unknown requirements.

3.7
hoshin kanri
method for management and deployment of strategic organizational policy

Note 1 to entry: English translations include policy management, policy deployment, management by policy, and strategy deployment.

4 Basic concepts of QFD

4.1 Theory and principles of QFD

Quality function deployment is an approach for ensuring quality throughout but not necessarily at each stage of the product development process, starting with the initial product concept. In 1987, the co-founder of QFD, Yoji Akao, defined comprehensive QFD as converting the "consumers' demands into quality characteristics and developing a design quality for the finished product by systematically deploying the relationships between the demands and the characteristics, starting with the quality of each functional component and extending the deployment to the quality of each part and process. The overall quality of the product will be formed through this network of relationships."[2] Since that time, QFD users have extended QFD and its applicable methods and tools upstream in the product development process to initial project strategy and downstream to the commercialization and even retirement of the product from the market. The network of relationships becomes a framework for new product development. QFD can be applied to products, services, and processes (hereafter referred to as products).

As a quality method, the aim is to assure that decisions regarding product development have a defined and repeatable process, are based on factual information, have definable and measureable targets, involve all relevant business departments, and focus first and best efforts where they matter most to customers. QFD should begin upstream in the product development process in order to assure that decisions are made in this way, as downstream rework can be costly in terms of money and delays.

The principles of QFD are as follows:

a) prioritize information to focus;

b) understand how to cause good quality;

c) listen to the voice of the customer;

d) observe the customer's situation;

e) capture information from other sources;

f) improve internal communications through the transformation of information between perspectives.

4.2 QFD use of the word of function

In modern organizations, the "quality function" shall collaborate and coordinate with other functions (marketing, engineering, manufacturing, service support, information technology, and others involved in product development) in order to assure customer satisfaction with the resulting product. Thus, the quality function is deployed (hence, the term QFD) across critical business activities and ideally across the entire organization.

NOTE The term function is used in multiple ways in QFD. The following are some of the common uses.

In the term quality function deployment, function refers to the organizational units, in this case, the quality function that is often tasked with process control, improvement, inspection, and other related activities.

In the term function deployment, function refers to product function, defined in value engineering and function analysis as a verb (active) + noun (measurable) that describes what a product does but not how it does it regardless of the level or perspective.

4.3 Spirit of QFD

A commitment among all critical departments to work together for the benefit of the customer or stakeholder. A personal connection to the customer should be established.

As a central principle, customer needs or requirements shall be known or acquired and understood adequately by all relevant stakeholders. It shall be validated if product requirements meet the needs of the customer or stakeholder.

4.4 Display of information

Visual display of information improves communications. Due to the various organizational functions in the QFD team and the complexity of the information as it flows through the development and commercialization process, visual displays of the information are helpful. This is especially true in global organizations with many languages and cultures.

5 Integration of QFD and product development methods

5.1 QFD support for product development methods

Integration of QFD into new product development processes is both desirable and possible. Successful integration has been accomplished with other product development methods such as Stage-Gate™[1)] and product development support methods such as Design for Six Sigma, Design for Lean Sigma, and others. This may be done at an enterprise level, business group level, project level, or technology level. This integration should be guided by a QFD expert familiar with these methods.

NOTE 1 QFD is designed to link together the various phases of product development such as strategy, portfolio, marketing, competitiveness, systems, voice of customer, requirements analysis, concept development, optimization, change management, reliability, cost, safety, manufacturing, support, logistics, quality, and other product development phases. This linking assures that priorities at each phase are supported by downstream phases and decisions at each phase can be viewed for their impact on upstream phases. In this way, QFD improves both the product and the process by which it is created.

NOTE 2 QFD can integrate tools and methods from different new product development processes. Conversely, different new product development processes can utilize QFD tools and methods.

NOTE 3 The applicable tools lists are not exhaustive. They are meant to illustrate tools that have been effectively used in QFD. Other tools might also be useful according to the project.

5.2 Flow of product development with QFD

5.2.1 Organization of the QFD flow

The flow of QFD methods and tools may vary according to the organization and project requirements. Typically, they begin with broad concerns and through prioritization flow down to specifics. Figure 1 illustrates the organization of the clauses of this part of ISO 16355. Each box describes the general stage in product development such as project, customers, and so forth. Within each box are specific steps and their respective clause numbers such as "8.2.1 Identify customers" and so forth. Later in this part of ISO 16355, each clause will describe the step and suggest applicable methods and tools that can be used to accomplish the step. This helps align the voice of the business, voice of the customer, voice of the engineer, and voice of the process.

1) Stage-Gate™is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

5.2.2 Flow chart of product development with QFD

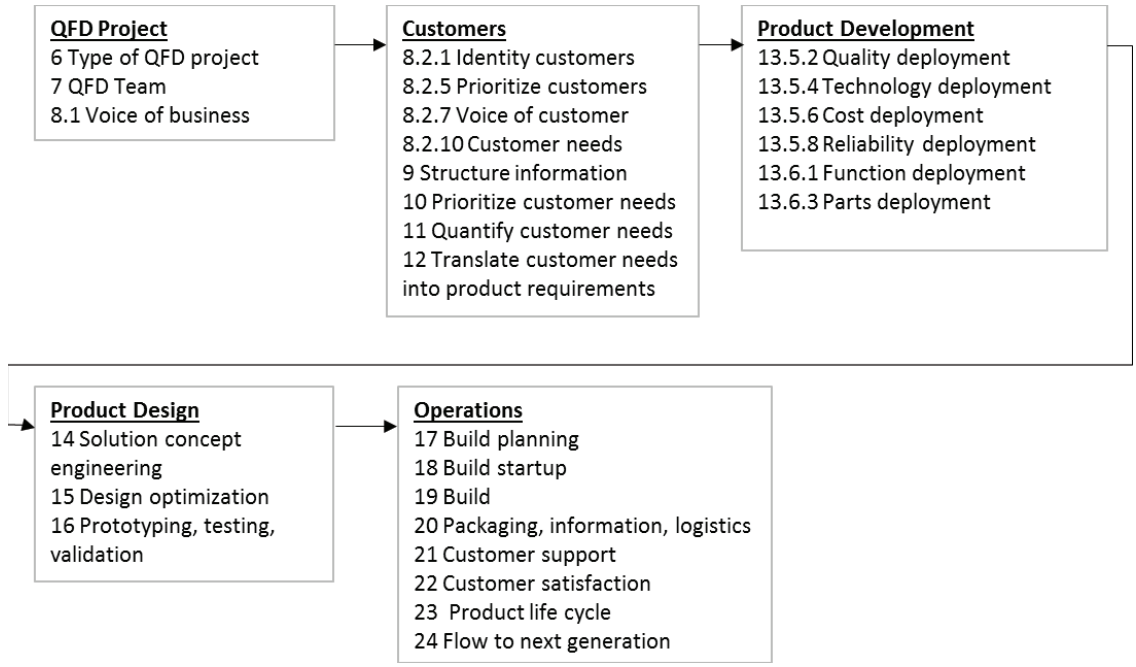

Figure 1 — Flow chart of product development with QFD

6 Types of QFD projects

6.1 General

QFD projects can encompass new developments, as well as generational improvements to existing products.

a) QFD can be applied to both existing and new markets, as well as to both existing and new technologies.

b) QFD projects can be driven by external sources such as market and customer demands, competitive threats or opportunities, technology change, regulatory changes, and other external factors, as well as internal sources such as cost reduction, manufacturing opportunities, new materials, knowledge management, and other internal factors.

c) QFD projects can focus on hardware, service, software, software as a service, process, systems, interface, or some combination. They can be either business-to-consumer (B2C) or business-to-business (B2B). Big, complex projects may benefit from increased customer involvement. Methods such as continuous QFD (see A.25) may be helpful.

d) QFD projects can be applied at any level: societal, environmental, end product, system, subsystem, component, production, material, process, service process, support, or supplier. Projects may progress upstream from micro detail to macro systems, downstream from macro to micro, or expand outward from a midstream level. QFD projects may have defined launches or may be continuous.

e) QFD may be employed at any management level from business operations to strategic business planning and control.

f) QFD projects may be used to document and preserve market and technical knowledge of the organization.

The QFD tools and the sequence in which they are used should be adapted to the type of project.

The QFD tools and sequence should be adapted to the management structure and culture and problems of each organization to improve participation, integration, and long-term utilization of the method. There is no “one way” to do QFD that fits all organizations.

QFD tools and sequence have evolved since the first studies in the 1960s in the automobile parts industry that used simple diagrams and matrices to identify design elements and downstream manufacturing details. When end-user products, non-manufactured products such as service and software, and business processes began using QFD, additional tools were added to address human tasks, information, and other complexities (see A.22). In more recent years, organizational resource constraints have led to a quicker approach that addresses both complexity and speed (see A.23). It is consistent with quality methods in general and with customer-driven methods like QFD in particular that the methods and tools should evolve and adapt to the ever-changing business environment of its practitioners, in order for them to remain viable and practicable. This evolution is demonstrated in the Bibliography of case studies.

NOTE QFD is not a method to design a product or process; it is an infrastructure to ensure the product or process satisfies customers.

6.2 Applicable methods and tools

a) Systems engineering

b) Stage-Gate™[2)]

c) Design for Six Sigma phase activities

d) Design for Lean

e) Cross-functional management swim-lane charts

f) Knowledge management

g) Continuous QFD (see A.25)

7 QFD team membership

7.1 QFD uses cross-functional teams

The basic concept of QFD is to ensure quality throughout each stage of the product development process while keeping the focus on customer satisfaction. Team membership should consist of a core team and invited subject matter experts.

7.2 Core team membership

Core team members should represent business functions needed for the project. They should extend end-to-end across the development and commercialization process to prevent information gaps from diminishing customer satisfaction.

7.3 Subject matter experts

Subject matter experts whose speciality is required to develop and review requirements may be invited as the project requirements flow down to different departments in the organization. Common experts include marketing (consumer insights, consumer experience, statisticians, conjoint analysis, survey design, and other marketing areas), engineering (electronics, components, value engineers, software, materials, packaging, and other engineering areas), manufacturing (stamping, forming, equipment, supply, industrial, and other manufacturing areas), quality (Six Sigma, statisticians, inspection, gage,

2) Stage-Gate™is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

design of experiments, supplier quality, and other areas activities), services (technical writers, technical support, phone centers, and other service areas), as well as other areas of expertise.

7.4 QFD team leadership

QFD team leaders or moderators should be trained in the QFD tools and methods in order to effectively lead the QFD project. Additional tools, as identified in the appendices, may be useful. Basic team facilitation and moderation skills are recommended.

The QFD team leader should take a position of being function-agnostic so as to remain neutral to any business department or activity.

8 QFD voices

8.1 Voice of business

8.1.1 Since QFD is applied to projects, these projects have many goals or objectives for the organization. Constraints may also exist. These goals may derive from development decisions and business strategy.

8.1.2 Business and project goals may include financial targets such as revenue, profit, and facility and resource optimization, marketing targets such as market opportunity, market share, market growth, and competitiveness, and others.

8.1.3 Constraints may include time/schedule, human resources and technical expertise, and cost/investment.

QFD is a quality method, so the goals and constraints should include a metric and measurement method, current performance level of the metric, desired performance level of the metric, timeframe in which to achieve the desired performance level of the metric, and who will judge if the desired performance level of the metric has been met within the timeframe.

8.1.4 Applicable methods and tools

a) Strategic planning methods
   1) Hoshin kanri (policy management)
   2) Porter five force analysis
   3) Kotler's market portfolio planning
   4) Blue Ocean Strategy
   5) New Lanchester strategy for sales and marketing
b) Balanced scorecard
c) Project prioritization and selection using the analytic hierarchy process (AHP)
d) Project goals table (see A.2)
e) Project goals prioritization with AHP (see A.3)
f) Heterarchy diagram