EQUID Design Process Guidelines

Requirements for ergonomic quality management in the design process for products and services
Version 2.0

EQUID (Ergonomic Quality In Design) Technical Committee
International Ergonomics Association

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Nael M., Bobjer O., McLoone H., Kwahk J.K., Friesdorf W., Glende S. and Bruder R.

Introduction

This document has been developed to provide guidance on the term “Ergonomically Designed Product”. To legitimately use this description, the product shall have been developed using a process that incorporates *ergonomics* principles during the design process. This is referred in this document as the “*EQUID Design Process*” *(When a word is in italics, its definition can be found in the “Definitions” section, page 3)*.

The main target users of this document include ergonomists and designers of *products* and *services* together with managers responsible for their development.

This document describes the basic requirements to certify that a design process follows the *EQUID Design Process.*

Applying the *EQUID Design Process* requirements has the following benefits for an *organization*:

- A better opportunity to supply *products* that fit users’ needs (in this document, the word “*product*” can also mean “*service*”)
- A chance to increase the quality of *products* in the opinion of users and the general public (or to increase the perceived quality of *products*).
- Reduced customer support costs. Users don’t ask for as much help with *products*, so after-sales costs are lower.
- Designing ergonomic *products* for the public is a good way to promote the *product* and the *organization*.

Important note
This document describes the conditions that are necessary to design ergonomic *products*. The goal is to deliver ergonomic *products* by the end of the design process. But certifying a process is not certifying a *product*, although there is a better chance to have an ergonomic *product* when following the *EQUID Design Process* requirements.

This document describes five groups of requirements:

1. Organization management
2. Initial definition of the user requirements
3. Design reviews
4. Final ergonomic evaluation
5. Evaluating after-sales user satisfaction

The organization management makes decisions that will have an effect on the ergonomic quality of products. Therefore, its role in this matter shall be clearly defined (Part 1).

The most important ergonomic inputs into the design process are described in:

- Part 2: Initial user requirements document and possible changes.
- Part 4: Final ergonomic evaluation report.
- Part 5: User satisfaction evaluation reports (after-sales).

The evaluation of mock-ups and the decisions management makes during design reviews (Part 3) is also very important for the control of the ergonomic quality of the final product.

The diagram on page 2 shows these key points and the corresponding documents to be produced.

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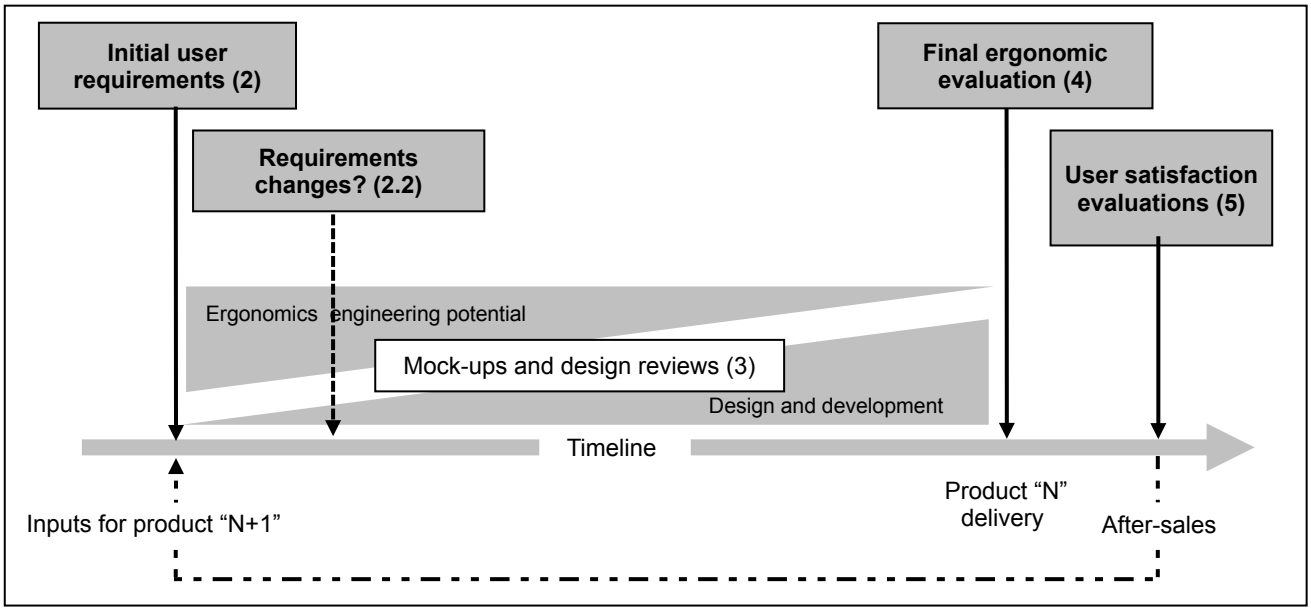
* Details on the making of this document and its validation process are presented in Nael 2001 (Appendix 1).

EQUID Design Process diagram



Ergonomic quality or usability is seen to be an essential aspect of the perceived quality of *products*. Therefore, the *EQUID Design Process* is consistent with ISO 9001:2000 (Quality management systems – Requirements). However, in ISO 9001, requirements to include *ergonomics* in the design process are only implicit. This document makes these requirements explicit through a defined set of deliverables to be produced during the design process. In fact, it is a reference document that addresses "ergonomic quality management" within the design process for *products* and *services*.

An organization may claim certification for all its design processes or for only a limited number of its design processes.

- In the first case, the requirements would apply to the entire organization.
- In the second case, the requirements would only apply to the design process of a specific *product* or *product* line.

In either case, the scope of the certificate is made completely clear to the public.

This EQUID document does not intend to conflict with, or replace, other ergonomic standards that already exist (see Appendix 1, Relations with existing standards). It is for any kind of industry or *service* and is common to all *products* and *services*. Appendix 1 also refers to specific industries. Others may be added in future versions of the document.

Applying and claiming an *EQUID Design Process* is a strategic decision for an organization. It means keeping to the requirements that are defined in this document. But this document does **not** claim that the structure or documentation of *product* design projects should be the same for every *product* or for every *organization*. It is a framework to be adapted to each *organization.*

All the requirements shall be documented although it is not necessary to produce long documents.

Definitions

* ***Certification Body:*** An independent organisation involved in assessing processes, *products* or *services* to meet specified criteria. They may issue certificates based on their criteria.
* ***Designer:*** A person, or a small group of persons, who are most strongly involved in the creative activity in a design process. “Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. […]. It involves a wide spectrum of professions in which products, services, graphics, interiors and architecture all take part. Together, these activities should further enhance - in a choral way with other related professions - the value of life”. (extracts from the ICSID definition, International Council of Societies of Industrial Design).
* ***EQUID Design Process****:* A set of requirements for the ergonomic quality of the design process for *products* and *services*. This will follow state-of-the-art *ergonomics* engineering. The requirements are defined by the International *Ergonomics* Association (IEA) in the present document.
* ***Ergonomics / study of human factors****:* A scientific discipline that studies the interactions between humans and other elements of a system. Also, the profession that applies theory, principles, data, and methods to design, in order to optimize human well-being and overall system performance (IEA definition and ISO 6385:2004). Most of the time, “*ergonomics*,” “human factors,” and “*usability*” have similar meanings.
* ***International Ergonomics Association:*** The IEA is the professional association representing the domain of *ergonomics*. Members of the IEA have developed the *EQUID design process*, however, the IEA has no role in *product* or *service* certification programs.
* ***Organization****:* A legal entity that claims, or applies for, certification of conformity of its design process with the *EQUID Design Process*. It may be a company, a manufacturer, a *service* provider, a public *organization*, a provider or a subcontractor of one of those, etc.
* ***Product****:* Hardware and software that is used by a human. This includes user’s manuals and other things necessary to use the *product*. In this document, the word “*product*” can also mean “*service*.”
* ***Qualified ergonomist****:* A person who has the theoretical and practical knowledge necessary to apply *ergonomics* to particular *products*. This person is certified by a recognized academic or professional authority. This person may be internal or external to the organisation. Ergonomists who are certified by an IEA-accredited body, such as CREE (Centre for Registration of European Ergonomists), BCPE (Board of Certification in Professional *Ergonomics*), JES (Japan Ergonomics Society, Certification Program for Professional Ergonomists) offer an extra guarantee of competence.
* ***Service****:* (See *“Product”*)
* ***Usability****:* The extent to which a *product* can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO 9241-11:1998, definitions 3.1). Some extra characteristics, such as learnability and flexibility, are also required for interactive *products*.
* ***User****:* A person who uses a *product* or *service* to achieve a goal. This also includes secondary *users*, such as persons involved in manufacturing, maintaining, recycling a product and *service* personnel, or other persons who may be affected indirectly by the using of the *product*.

EQUID Requirements

1. *Organization* management and documentation

1.1 Management commitment

- Top management shall show evidence of its commitment to apply state-of-the-art rules and methods in *ergonomics* and ergonomic engineering.
- Top management shall communicate, throughout the *organization*, the importance of meeting the *user* requirements.
- Management has regular meetings to review the project and to consider questions of *ergonomics*.
- *"Top management shall ensure that customer requirements are determined and are met with the aim of enhancing customer satisfaction"* (ISO 9001:2000 § 5.2).
- Top management shall document evidence of this (ways and means, decision reports).

1.2 Quality policy, quality objectives, and management planning

Top management shall:

- Document the ergonomic quality objectives and economic rationale for applying *ergonomics* in the design process.
- Set ergonomic quality objectives at relevant functions and levels. The objectives will consider the purpose of the *organization*. Ergonomic "*quality objectives are measurable and consistent with the quality policy."* (ISO 9001:2000, § 5.4.1)
- Plan ergonomic tasks to meet the quality objectives. These main tasks are documented in:
  - The "Initial Definition of the User Requirements" (Part 2).
  - The "Final Ergonomic Evaluation" (Part 4).
  - The after-sales "User Satisfaction Evaluations" (Part 5).
- Define the way the ergonomic inputs (mainly Parts 2, 4, and 5) are considered.
- Perform and document regular evaluations of the costs and benefits of the resource spent in *ergonomics*. This includes consideration of after-sales costs and *user* satisfaction.

1.3 Responsibility, authority, and communication

- Top management shall appoint a management person to:
  - Set up, carry out, and maintain state-of-the-art ergonomic practices.
  - Report to top management on ergonomic performance.
  - Communicate the ergonomic quality objectives within the organization.

1.4 Management reviews

- Management reviews shall regularly examine:
  - The user requirements (see 2.1).
  - Reports on ergonomic evaluations of test prototypes, if any (see 3.2).
  - Reports on final ergonomic evaluation before commercial delivery (see 4.1).
  - Reports from user satisfaction evaluations (see 5.1).
- At the beginning of the design process, management shall approve the definition of the initial requirements of *users* (Part 2).
- During the design process, management shall make decisions for corrective actions, to improve the *product* according to *user* requirements.
- Before the *product* is delivered, management shall consider the results from the final ergonomic evaluation. Management shall then make a decision whether to deliver or modify the *product*.
- Management shall make reports of all decisions in ergonomic matters.

1.5 Competence, awareness, and training of human resources

- A qualified *ergonomist* who has demonstrated ergonomic competencies relevant to the *product* design process shall participate regularly. The *ergonomist* shall supervise at least:
  - The Initial definition of the *user* requirements (see 2.1) and any changes (see 2.2).
  - The Final ergonomic evaluation (Part 4).
  - The After-sales *user* satisfaction evaluations (Part 5).
- Records are kept of the qualified *ergonomist*'s education, training, skills, and experience.
- The qualified *ergonomist* may be part of the human resources of the *organization*, or external with a written contract of employment from the *organization*.

2. *User* Requirements document(s)

2.1 Initial User Requirements document

User requirements shall include information that is necessary to help designers create innovative and ergonomic *products*. This information includes:

- The characteristics and the variation limits of the target *users*:
  - Categories of users, (including secondary users) such as: age, gender, background knowledge, experience, and skills.
  - The variation limits around the "average user", i.e. users' descriptions shall cover all sorts of target users. These limits will be made clear to the public.
- The intended context of use, possible variation limits, and their effect on the *user* requirements:
  - Intended context and possible variation limits around the "normal" context.
  - The effect of this context on the user requirements.
- The goals of *users*, to be met by the *product*:
  - Activities of users, related to the product.
  - Factors influencing users when they do something with the product.
  - Typical usage situations showing possible difficulties of users and main variations.
  - "Normal use" variation limits and incorrect usage to be avoided.
- *User* satisfaction reports on former versions of the *product* (see 5.1) or other similar products.
- Suggestions for solutions. These will be more detailed than standard guidelines.
- Performance criteria for the *ergonomics* of the *product*, including:
  - General criteria for typical use of the product (performance time, error rate, satisfaction, etc.).
  - Acceptable time limit to learn how to use the product.
  - A test plan for the ergonomics of the product. Show the targeted performance of the product for critical tasks.
  - Acceptance limits for the ergonomics of the product in a user test. This limit shall be set according to an initial evaluation plan.
- Relevant health and safety issues for *users*.
  - Applying standards or regulatory requirements (if any).
  - Criteria for comfort and health (minimize forces, repetitions, awkward and static postures).
- Planned after-sales help for *users*. User assistance information and the means to communicate that information.

The *user* requirements shall be clear and not in conflict with each other. When some requirements seem to contradict others, the contradiction and its explanation shall be clearly stated. Optional directions shall be given to solve the issue.

The *user* requirements shall be stated in a document. All persons involved in the design process can refer to this document. The document shall be easy to understand for all project partners and management representatives.

Notes:

- This document can be in any form: text, drawings, storyboards, videos, narrative scenarios, or a mix of these.

- This document will indicate directions for creative design. It will not be limited to authoritarian requirements, although some strict requirements may be necessary (e.g. safety issues or a few specific dimensions).

2.2 User Requirements Changes

- When any part of the initial definition of the *user* requirements is changed during the design process, the change shall be reported in the "*User* Requirements" document.

3. Design reviews

3.1 Design and development planning

Management shall:

- Plan ergonomic reviews according to the design and development stages.
- Plan ergonomic evaluations of intermediate samples of the *product* (if any).
- Make the responsibilities and authorities clear for decisions based on the ergonomic evaluations results.

3.2 Design and development reviews

- During the regular reviews of design and development (see 1.4), report and discuss ergonomic issues in order to:
  - Compare the results of intermediate ergonomic evaluations with the defined performance criteria for the *ergonomics* of the *product* (see 2.1 and 2.2).
  - Identify any problems.
  - Propose necessary actions.
  - Management shall make decisions on proposed actions.
- The organization shall keep records of the results of the reviews and decisions.
- The organization shall document what design review(s) is applicable for a particular product and, if applicable, reasons for not doing design reviews.

4. Final ergonomic evaluation report and management decision

4.1 Design and development validation

Management shall always:

- Validate ergonomic aspects of the *product* before delivering the *product*.
  "*Design and development validation shall be performed in accordance with planned arrangements to ensure that the resulting product is capable of meeting the requirements for the specified application or intended use, where known. Wherever practicable, validation shall be completed prior to the delivery or implementation of the product. Records of the results of validation and any necessary actions shall be maintained." (*ISO 9001:2000, § 7.3.6)

Note: Verification based on checklists or expert inspection only is **insufficient** to validate the *ergonomics* of the *product* (see "ergonomic evaluation process" below).

- Perform ergonomic validation in reference to the defined *user* requirements (see 2.1 and 2.2). This validation shall include:
  - Controlling conformity with standards:
    - Complying with health and safety standards and the general safety obligation for consumer products.
    - Complying with relevant ergonomic standards (if not, give reasons).
    - Complying with relevant industry standards (if not, give reasons).
  - Completing the final ergonomic evaluation process. There are two documents to provide:

    a) Before the evaluation, create a preparation document that includes:

- Evaluation procedure, conditions, and *user* test scenarios.
  N.B. Users' notices shall be considered as a part of the product.
- Characteristics of the sample of test *users*.
- Objective and subjective evidence to be collected.
- Links to the *user* requirements (Part 2).
- Conditions for a "go / no go" decision. Threshold for acceptance by *users*.
- This shall be validated by management.

b) After the evaluation, create a final ergonomic evaluation report that includes:
- Compliance with the definition of the requirements of *users* (Part 2). If not, it explains actions to take.
- The possible effects on sales and after-sales costs in cases of no compliance.

Note: When a component or part of the final *product* comes from another *organization*, its possible effect on the *ergonomics* of the *product* shall be evaluated.

4.2 Management review of evaluation results compared to the user requirements

- Management shall perform a review before the *organization* commits to delivering the *product* to *users*. This evaluation shall include a discussion of the final ergonomic evaluation, which will help the management make the "go / no go" decision.

5. *User* satisfaction evaluation reports

5.1 Monitoring and measuring after-sales user satisfaction

- Regularly, the *organization* shall collect and analyse data that gives information about:
  - After-sales *user* satisfaction and user complaints.
  - Whether the *product* complies with the definition of the *user* requirements (Part 2).
- The *organization* shall keep records of after-sales ergonomic issues and related costs and estimated benefits.

5.2 Control of a product that does not conform and corrective actions

- When a *product* does not comply with the *user* requirements, the *organization* shall eliminate the nonconformity.
  The *organization* "*takes action to eliminate the cause of nonconformities in order to prevent recurrence: reviewing nonconformities (including customer complaints), determining the causes of nonconformities and reviewing corrective action taken." (*ISO 9001:2000, § 8.5.2)
- When an unintended use of the *product* risks the health and safety of *users*, the *organization* shall eliminate the nonconformity.
- If the correction of the nonconformity might affect the *ergonomics* of the *product*, the *product* shall be evaluated again after modification.

5.3 Monitoring and continual improvement

- The organization shall apply suitable methods for monitoring the ergonomic quality management, and continually improve its effectiveness through audit results, analysis of user satisfaction data, corrective and preventive actions.

Appendix 1

Relation to other standards or guidelines

Quality management

- ISO 9001 Quality management systems - Requirements

Ergonomics

- ISO 6385 Ergonomic principles in the design of work systems
- ISO 13407 Human-centred design processes for interactive systems
- ISO 9241-10 Ergonomic requirements for office work with visual display terminals – Part 10: Dialogue principles.
- ISO/TS 20282-1 Ease of operation of everyday products – Part 1: Design requirements for context of use and *user* characteristics.
- ISO/TS 20282-2 Ease of operation of everyday products – Part 2: Test method for walk up and use *products*.
- ISO/IEC 23025 Common industry format for usability test reports.
- Directive 2006 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC
- EN ISO 614-1 Safety of machinery. Ergonomic design principles, Part 1: Terminology and general principles.
- EN ISO 614-1 Safety of machinery. Ergonomic design principles, Part 2: Interactions between the design of machinery and work tasks.
- IEC 60601-1-6 Medical electrical equipment - Part 1-6: General requirements for basic safety and essential performance - Collateral standard: Usability

IEA references

- Ergonomics Quality In Design: http://www.iea.cc/project/project_equid.html
- Ergonomics in Design for All: http://www.iea.cc/about/technical.php?id=56d641e4ddc48
- Nael M. 2011. IEA EQUID Template for Cooperation between Product Designers and Ergonomists in *"Human Factors and Ergonomics in Consumer Product Design"*. Karwowski W., Soares M., Stanton N. eds. pp. 261-271. CRC Press.

Appendix 2

Guidance for non specialists in Human Factors practice

Usability performance acceptance threshold to a defined evaluation protocol

For example, 80 – 100% success, such as measured with the Systems - Usability - Scale (cf. bibliography).
N.B. 1. Performance criteria for a general public *product* may be acceptable with 80% success but, for *products* to be used in a professional context, a 100% success threshold may be required.
N.B. 2. Performance criteria shall include ease of use and efficiency of the overall system (*product* in context of use).

N.B. 3. Existing dialogue principles, such as in ISO 9241, can help define *usability* performance criteria.

Basic requirements for a usability test

- Recruitment of a sample of people (10 users, per category of users, is a minimum) who belong to the *product* / *service* target *users*.
- Usage scenario based test sessions (for example: edit, modify, delete a directory element, switch between normal and predictive modes, describe the content hidden under the terms in the main menu, under the icons, etc.). Each person has to carry out the predefined scenarios, without assistance from the experimenter. The basic scenarios shall be carried out without any help from the manual, which shall also be evaluated through several scenarios.
- Test procedure and environment shall be as natural and realistic as possible. For general public *users*, no detailed explanations are given on operating procedures; scenarios are designed as goals to be reached. It is highly recommended that the experimenter is qualified in Human Factors Sciences.
- Main indicators to be considered to conclude about *product* acceptability are: number of persons who have reached the scenario goals, time to execute the scenarios, number of errors and hesitations, spontaneous expressions, answers to questions on terminology and icon understanding.
- Competitive *usability* tests between the *product* and other *products* with technical or functional similarities can be relevant to assess *user* acceptance.

See also in Appendix 1: ISO/TS 20282-2:2006 Ease of operation of everyday *products* – Part 2: Test method for walk up and use *products*.

Objective and subjective evidence to be gathered

Usability evaluation shall be supported by some observational data of *users'* behaviour and not rely on verbal data (e.g. interviews or questionnaires) alone.

Final usability evaluation report, in a standard format

Basic structure of a final *usability* evaluation report usually includes:
- Executive summary (2 pages: evaluation objectives reminder, evaluation technique and conditions, evaluation limits, key results, conclusions)
- Evaluation details (evaluation protocol, technical description, full results, tables)

The ISO/IEC 23025 format may also be helpful (cf. Appendix 1).

Easy to read bibliography

- Brooke, J., 1996, *SUS: a "quick and dirty" usability scale, in: Usability evaluation in industry*, edited by Jordan, P.W. & al. Taylor & Francis.
- Dul, J. and Weerdmeester, B. , 2008, *Ergonomics for Beginners, A Quick Reference Guide*, Third Edition, CRC Press, Taylor & Francis.

Short examples of documents to be maintained by the organization

The following tables provide a frame to organize the documentation to be produced during the design process. These have to be adapted to specific industry contexts. Brief and precise documents are recommended.

Product "XYZ" **Initial *user* requirements definition**		
2.2	*User* categories definition	
	User categories variation limits	
	Intended context of use	
	Context variation limits	
	Effect of context on *user* requirements	
	Users' activities related to *product*	
	Typical usage scenarios	
	Potential health and safety issues	
	Usability performance criteria	
	Etc.	
Comments: consistency with quality policy of the organization?		

Product "XYZ" **Final ergonomic / *usability* evaluation: a) Preparation document**		
4.1. a)	Evaluation procedure and conditions	
	Description of sample of test *users*	
	Test scenarios description and schedule	
	Indicators to be collected, objective and subjective	
	Target performance to *user* test, related to *user* requirements definition	
	Etc.	
Comments: consistency with user requirements?		

Product "XYZ" **Final ergonomic / *usability* evaluation: b) Evaluation report**		
4.1. b)	Description of actual test conditions, *users'* sample, etc.	
	Performance results (number of successes, failures, etc.)	
	Potential effect on after-sales and *user* assistance	
	Etc.	
Conclusion: The results are acceptable, or unacceptable, for product delivery? If not, what kind of action is to be taken?		