



Designation: E2350 – 19

Standard Guide for Integration of Ergonomics/Human Factors into New Occupational Systems¹

This standard is issued under the fixed designation E2350; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to assist in the integration of ergonomic principles into the design and planning of new occupational systems from the earliest design stages through implementation. Doing so may reduce or eliminate the necessity for later redesign that could have been foreseen.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

E1542 [Terminology Relating to Occupational Health and Safety](#)

3. Terminology

3.1 For definitions not in this standard related to this guide, refer to Terminology E1542.

3.2 *Definitions:*

3.2.1 *administrative controls, n*—work practices and policies that are implemented with the objective of enhancing human well-being and overall system performance through the way work is assigned or scheduled; examples may be found in [Appendix X1](#).

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.2 *benchmarking, v*—identifying of best practices against which to compare the effectiveness of a process or design; examples may be found in [Appendix X1](#).

3.2.3 *business outcome, n*—required products or services or both, that is, the desired and essential qualities and quantities of the end product of the occupational system.

3.2.4 *design team, n*—departments or individuals or both involved in or consulted during the design process, including representatives of those who are involved or affected by the design; examples may be found in [Appendix X1](#).

3.2.5 *engineering controls, n*—physical changes to jobs that are implemented with the objective of enhancing human well-being and overall system performance through the design and modification of the work equipment, facilities, or processes, or combinations thereof; examples may be found in [Appendix X1](#).

3.2.6 *ergonomics/human factors, n*—scientific discipline concerned with the understanding of interactions among humans and other elements of a system and the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance. (International Ergonomics Society)

3.2.7 *job, n*—set of tasks performed by one or more workers.

3.2.8 *knowledge base, n*—organized body of information applicable to the integration of ergonomics into new occupational systems, including both general ergonomic resources, such as those found in the bibliography, and the experiences of the organization.

3.2.8.1 *general knowledge base, n*—ergonomic textbooks, guidelines, recommendations, reports of other companies' ergonomic programs, and so forth.

3.2.8.2 *internal knowledge base, n*—organized account of the organization's positive and negative experiences with occupational processes.

3.2.8.3 *project knowledge base, n*—working collection of experiences for the current project in which decisions made at each stage are added to the project knowledge base for use at later design stages, and after the completion of a project, the project knowledge base is integrated into the internal knowledge base.

3.2.9 *occupational ergonomic risk analysis, n*—occupational ergonomic risk analysis may include, but is not limited to, the evaluation of force (including dynamic motion), repetition, awkward or static postures, contact stress, vibration, and physiological and environmental factors such as temperature and other ambient air conditions and occupational ergonomic risks can be affected by workers' lifestyles and other nonoccupational risk elements.

3.2.10 *occupational system, n*—integrated collection of personnel, facilities, equipment, tools, raw materials, techniques, and other resources organized to produce a product or service.

3.2.11 *task, n*—group of related activities that comprises a component of a job.

3.2.12 *workers' capabilities and limitations, n*—those personal characteristics that workers bring to a job, such as:

Physical strength, endurance, agility, and skill and
Mental abilities, techniques, and knowledge developed through training, experience, and education. Examples may be found in [Appendix XI](#).

4. Summary of Guide

4.1 This guide facilitates the integration of ergonomic principles into the design of occupational systems. It is assumed that there will be more than one iteration of the process, proceeding from the general and becoming more detailed with each iteration. The number of iterations will depend on the complexity of the process.

4.2 The evaluation begins by defining the business outcome, that is, the essential qualities and quantities of the end product or service.

4.3 After identifying the required process elements (physical and operational components), tasks are allocated to machines or workers.

4.4 The jobs are then analyzed to determine if they exceed worker capabilities and limitations.

4.5 Depending on the results of the analysis, the business outcome or jobs may be modified or action deferred to a later iteration.

4.6 Throughout the process, the knowledge gained is added to the knowledge base.

4.7 The operational audit evaluates the system as the design nears completion. It identifies and evaluates those issues either not considered or not apparent in previous stages. After the system is operational, periodic audits evaluate the effectiveness of the design.

5. Significance and Use

5.1 Integrating ergonomic principles into new occupational systems may help businesses develop processes that do not exceed worker capabilities and limitations.

5.2 Jobs and tasks that conform to worker capabilities and limitations may be performed more efficiently, safely, and consistently than those that do not.

5.3 The application of ergonomic principles to the processes involved in occupational systems may help avoid system failures and inefficiencies.

5.4 The integration of ergonomic principles at the earliest stages of process concept and design may facilitate appropriate design, layout, and allocation of resources and may reduce or eliminate the necessity for later redesign that could have been foreseen.

5.5 Designing jobs that fit the capabilities of larger population segments may increase an organization's accessibility to the available labor pool.

5.6 The integration of ergonomic principles into occupational systems may increase profit by lowering direct and indirect costs associated with preventable losses, injuries, and illnesses.

5.7 The bibliography contains a list of reference materials that may be useful in particular applications. All appendixes are nonmandatory.

6. Getting Started (see Fig. 1)

6.1 *Design Team*—Identify the departments or individuals or both who should be on the design team or consulted during the design process. They include representatives of those who are involved or affected by the design. Design team members may include representatives from engineering, labor, maintenance, marketing, vendors, safety and health professionals, and so forth, as appropriate.

6.2 *Allocate Responsibility*—Appoint members of the design team to be responsible for maintaining the knowledge bases, benchmarking, and the scheduling and performing of periodic audits.

6.3 *Business Outcome*—Determine the desired and essential attributes of the end product or service of the occupational system. The essential attributes of the end product or service determine what can and cannot be altered during the design process. They may include:

- 6.3.1 Manufacturing and assembly items,
- 6.3.2 Services to be provided,
- 6.3.3 Material to be delivered to the customer,
- 6.3.4 Specifications and acceptable tolerances,
- 6.3.5 Quality levels (allowable percentage of defects), and
- 6.3.6 The quantity of the product to be produced, including projections of future requirements.

6.4 *Knowledge Base*—Establish a knowledge base. Once a formal knowledge base exists, it will be used as a resource for the design project. Because experience gained during each project will be added to the knowledge base, it will grow and become essential to the design process. It includes the general, internal, and project knowledge bases. When first beginning to use this guide, it will be helpful to investigate similar occupational processes to see how problems were resolved and to identify experiences not added to the knowledge base. See [Section 3](#) for more information.

6.5 *Benchmarking*—Identify benchmarks by which to judge the effectiveness of the process or design. Benchmarks may include cost per unit, downtime, absenteeism, turnover rate,

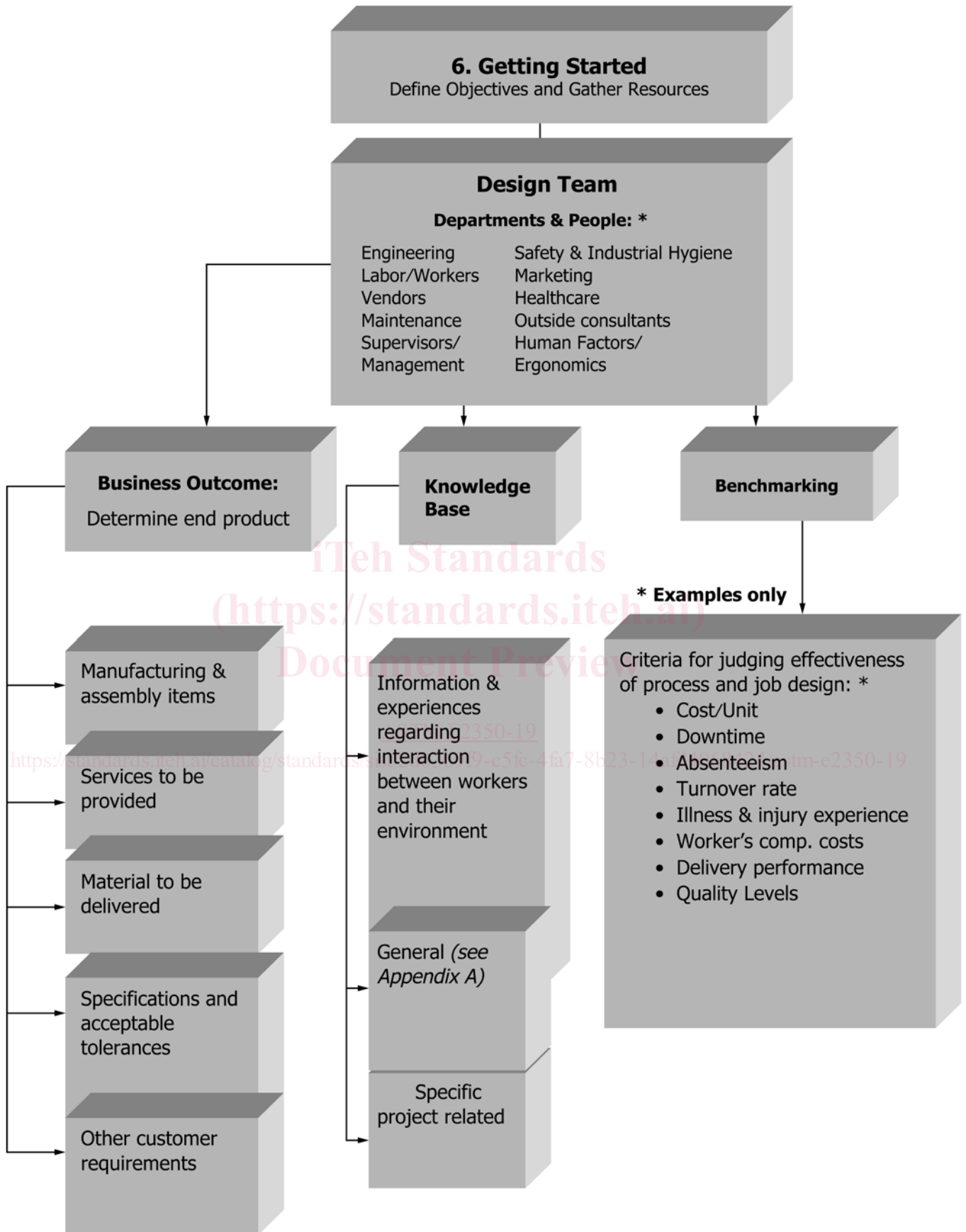


FIG. 1 Getting Started

workers' compensation costs, illness and injury experience, and delivery performance.

7. Evaluation of Process Elements

7.1 The evaluation of process elements is iterative (see Fig. 2). It begins with a broad identification of the issues and becomes more detailed with each iteration. Because each process is unique, this guide does not specify the number of iterations or what should be addressed in each iteration. Examples of issues to address may be found in Appendix X1.

7.1.1 *Identify Physical Components*—Identify equipment, machinery, materials, facilities, work environment, and so forth. Examples of elements to consider may be found in Appendix X1.

7.1.2 *Identify Operational Components*—Identify operational procedures and process elements: production methods, manufacturing and assembly activities, cycle times, materials handling, quality control, and so forth. Examples of elements to consider may be found in Appendix X1.

7.1.3 *Task Allocation*—Allocate tasks to workers or machines. This will be based primarily on the knowledge base, that is, experience with similar designs.

7.1.4 *Job Evaluation*—Determine the workforce capabilities and limitations that will be required by the process. Analyze the anticipated performance requirements of the processes. Evaluate the jobs and conduct an occupational ergonomic risk analysis. Examples of elements to consider may be found in Appendix X1.

7.1.4.1 *If worker capabilities or limitations are not exceeded*—Add the information to the project knowledge base and continue to the next level of evaluation.

7.1.4.2 *If worker capabilities or limitations are exceeded*—Modify the business outcome, task allocation, or add controls (engineering or administrative or both).

(1) *Change the business outcome*—It may be possible to modify the product or service as defined in the business outcome.

(2) *Modify the task allocation*—Review the task allocation and, if possible, modify those issues that have caused the conflict, including engineering or administrative controls, or both, or reallocation of tasks to machines. After modifying the task allocation, repeat the analysis.

(3) *Defer action*—If the task allocation cannot be altered, defer action to a later iteration.

7.1.4.3 *If no conclusion can be easily reached or if the extent of worker interaction has not yet been determined*—If there is insufficient knowledge or if the job demands appear to be close to performance limits, either modify the task allocation

so that the requirements do not exceed worker capabilities and limitations, plan for controls at a later stage, or include other considerations that may help decide if changes are needed. In this event, several steps can be taken:

(1) Estimate the relative likelihood or severity of loss or failure.

(2) Determine if controls are feasible.

(3) Determine if controls can be added at a later stage in the process so that action is not required during this stage.

(4) Identify possible benefits of modification or change that could generate a value added return when combined with worker performance gains.

(5) Reexamine the business outcome.

(6) Assess validity of underlying assumptions to future business.

8. Audit

8.1 At the completion of the evaluation, perform an audit of the business outcome; all processes, steps, and activities; and task allocations. This check will help determine if earlier evaluations correctly identified and controlled the ergonomic issues. If decisions made in the evaluation of process elements result in jobs that exceed or might exceed workers' capabilities and limitations, the steps in Section 7 shall be repeated and appropriate corrections made.

8.1.1 *Operational and Physical Components Audit*—Does the project knowledge base identify any issues not addressed during earlier stages?

8.1.2 *Worker-Task Interaction Audit*—Have all jobs and tasks been evaluated for performance requirements and compared to the knowledge base?

8.1.2.1 *If worker capabilities or limitations are not exceeded*—Add this information to the project knowledge base, and complete the evaluation by scheduling a follow-up audit.

8.1.2.2 *If worker capabilities or limitations are exceeded*—Make changes to bring performance within worker capabilities.

9. Periodic Audit

9.1 Schedule audits on a periodic basis.

9.2 Compare the performance of the system to the benchmarks established in 6.5.

9.3 Particular attention should be paid to monitoring those jobs or tasks where changes have resulted in conditions that may exceed workers' capabilities and limitations.

10. Keywords

10.1 ergonomics; human factors; occupational system; process design; work; work evaluation