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CONTENT AREA NO 2 WORK DEMANDS ANALYSIS & ERGONOMIC RISK ASSESSMENT

Project Title
Ergonomic workplace design for workers with disabilities and their long-term employment

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Lesson information

Description of content area

The module includes techniques for analysing work demands, assessing physical, cognitive, and organizational aspects of jobs, and identifying potential ergonomic risks. Students will develop skills in conducting ergonomic assessments and making evidence-based recommendations to improve workplace design.

Learning outcomes

- Attitudes: Students recognize that individuals with disabilities are equally at risk of developing musculoskeletal disorders as those without disabilities
- Skills: conduct ergonomic assessments and work demands analysis.
- Knowledge: Students understand the types and characteristics of various ergonomic assessment methods

Questions for discussion and/or self-assessment

1. How might the needs of workers with physical, cognitive, or sensory impairments influence the choice of ergonomic assessment method in a workplace?
2. When is it more appropriate to use a proactive (design phase) approach versus a reactive (existing work) approach in ergonomic assessment? Can you think of examples for each?
3. What trade-offs must be considered when selecting between high-tech simulation tools and low-cost pen-and-paper methods for ergonomic evaluation?
4. In your own daily tasks, can you identify a routine activity that could benefit from a Hierarchical Task Analysis (HTA)? What would the main goal and first-level subgoals be?
5. How does breaking down tasks into goals and subgoals (as in HTA) improve safety and training effectiveness in physically demanding jobs?
6. How might a Problem Identification Matrix (PIM) reveal accessibility barriers that are not immediately visible through simple observation?
7. What are the risks of relying solely on observational methods like REBA or KIM-ABP without consulting the workers performing the tasks?
8. Can digital simulation tools like HumanCAD or Pathfinder fully replace real-world ergonomic assessments? Why or why not?
9. Why is it important to define system boundaries when performing a task analysis? How could poorly defined boundaries affect your results?
10. Think of a workplace or job you know well. How might combining multiple assessment tools (e.g. HTA + PIM + REBA) offer a more complete understanding of ergonomic risks than using a single tool?

Introduction

Understanding the physical, cognitive, and organizational demands of a job is a critical step in designing safe and inclusive work environments. Work demands analysis and ergonomic risk assessment are essential tools in this process, providing structured ways to evaluate how job tasks align with the abilities and limitations of workers - particularly those with disabilities. These assessments help identify potential mismatches that may increase the risk of injury or reduce long-term work ability, laying the foundation for effective workplace design or modification.

There is no single method for conducting work demands analysis or ergonomic risk assessment. A wide range of tools and approaches are available, each suited to different contexts and goals. These include task analysis, observational checklists, and traditional pen-and-paper assessments, as well as more advanced, high-tech solutions such as digital motion capture, wearable sensors, or video-based posture analysis. The choice of method depends on the depth of analysis needed, the nature of the job being studied, and the available resources.

One important distinction between methods is the phase of implementation. Some tools are particularly useful during the planning and design phase of a job or workplace. For example, simulation-based tools that can predict future risks or design flaws before work begins. Other methods are more appropriate for analysing existing work environments, allowing practitioners to observe real tasks in real time and identify ergonomic risks based on actual worker performance. Both proactive and reactive approaches play a role in creating healthy and sustainable jobs.

In addition to timing and type, ergonomic assessment methods vary in their demands on time, budget, and expertise. Simpler methods, such as structured observation forms or checklist-based evaluations, can often be conducted quickly and with minimal cost. In contrast, high-tech systems typically require significant investment in equipment, software, and trained personnel. Choosing the right method involves balancing precision with practicality, ensuring that the assessment produces meaningful results without exceeding the available resources.

1. Analytical methods

1.1. Task analysis

Task analysis is a method used to break down tasks to understand how a task is performed. The main idea is to analyse all the steps, decisions, tools, and knowledge needed to complete a task, so you can improve it, teach it, or design systems around it. When it comes to physical tasks, task analysis is especially important because it helps ensure that movements, tools and environments are optimized for safety, efficiency, and effectiveness.

By breaking down a physical task into its component steps (e.g., picking up a tool, walking to a station, pressing a button), you can: i) improve efficiency or improve performance, ii) aid in equipment and Workstation design, iii) enhance safety, iv) reduce fatigue, v) standardize training.

Typically, a task analysis has the following steps:

1. Identify the task to be analysed.

2. Observe or interview people performing the task.
3. Break down the task into steps, goals, decisions, and required knowledge.
4. Represent the task using charts, diagrams, or structured lists.
5. Validate the analysis with real users or experts.
6. Use the analysis to redesign, train, or improve the task.

There are several approaches to performing a task analysis. One of the most common is Hierarchical Task Analysis (HTA), which breaks a task down into subtasks and goals in a tree-like structure, focusing on goals and plans rather than just physical actions.

First, decide what goal you want to achieve with your task analysis. Are you trying to make a training manual, improve a process, or understand how someone does a job? Once you know the purpose, gather information about the task by talking to people who do it, watching them work, or looking at written instructions. This helps you understand what needs to be done and what steps are involved.

Next, break down the main task into smaller parts. Think of it like a family tree, where the big goal is at the top, and it splits into smaller goals or tasks below it. Keep dividing each task into even smaller steps until you reach a level where it's clear what actions need to be taken. This makes the overall process easier to understand and analyse.

After creating this step-by-step breakdown, look at how the tasks flow together. Decide which steps happen first and which ones depend on others. Draw diagrams or make tables to show the order of actions, decisions to be made, and resources needed. Also, think about possible mistakes or problems that could happen at each step so you can fix or prevent them later.

Finally, check your task analysis with the people who do the work to make sure it's accurate. Ask for their feedback and make changes if needed. Once it's complete, you can use this information to write instructions, design better systems, or train new workers. Doing a good task analysis helps you understand and improve the way work is done.

Plans

Each goal in your hierarchy should be supported by a plan that describes when and how its sub-goals are carried out. Plans act as the control logic of your HTA, explaining the conditions under which each sub-goal is triggered. It's equally important to define the exit condition for each plan. Without a clear exit point, the task analysis may result in a control loop with no obvious way to complete or move on from the task. There are six typical plan types: fixed sequences (steps in a set order), contingent sequences (dependent on conditions), choices (select one of several options), optional completion (some steps may not be needed), concurrent operations (parallel steps), and cycles (repeating tasks). When writing plans, include contextual details such as time constraints, environmental triggers, system states, or required inputs. Table 1 presents notations used in HTA that allow to save space in the plans.

Table 1. Examples of notations used in HTA

Type of plan	Notation by text	Notation by symbols	Example
Linear	then	> or →	1 > 2 > 3 > 4
Non-linear	or	/	1/2/3/4
Simultaneous	and	+ or &	1+2+3+4

Branching	If condition X then	X? >	X? yes > 2 no > 3
Cyclical	repeat until		1 > 2 > 3 > 4 > 1 > ...
Selection	Any of	:	1:2:3:4

The hierarchical list below demonstrates a basic example of a HTA for the goal "Make a cup of tea." Because this is a familiar and relatively simple task, only one level of subgoals is used. However, in situations where the task is performed in an unfamiliar environment (such as someone using a new kitchen) additional subgoals may be needed. For example, you might include steps for locating the kettle, teabags, teacup, sugar, or milk.

Similarly, subgoal 5, ‘Add milk’, could be expanded to include a subgoal like "Check the milk's expiry date" to ensure safety. The structure of Plan 0 doesn’t have to follow a strict sequence - adding sugar or milk may be optional, depending on personal preference.

Review the HTA below and modify it to reflect how you typically prepare a cup of tea:

0. Make a cup of tea
   Plan 0. Do 1 >2>3>4>5 then exit (i.e. drink tea)
1. Boil water
2. Place a teabag in cup
3. Pour in hot water
4. Add sugar
5. Add milk

Task analysis is a core method in ergonomics and is widely applicable in many other fields as well. The most effective way to learn and master task analysis is through hands-on practice. Below are several sample tasks that are well-suited for practicing Hierarchical Task Analysis (HTA):

1. **Water a houseplant** - A simple task with a clear beginning and end. It’s a good starting point for practicing goal hierarchies and identifying exit conditions in a plan.
2. **Brush teeth** - A familiar routine task with clearly defined steps. It also introduces optional subgoals, such as using mouthwash or dental floss.
3. **Pack a school bag** - Involves both physical actions and light decision-making. This task provides an opportunity to practice condition-based subgoals (e.g., pack lunch only if staying all day).
4. **Use the toilet** – Although highly routine, this task is useful for practicing complete task breakdown, including preparation, hygiene, and optional steps. It can also be adapted for different user needs or environments.

Tips for beginners

When starting your Hierarchical Task Analysis (HTA), begin by clearly defining both the purpose of the analysis and the system boundaries. The boundaries will depend on your objective. For example, if you're creating a job description or personnel specification, you may only need to examine the tasks carried out by a single individual. If you're studying how a team communicates and coordinates, your analysis should include the tasks of the whole team. And if you're determining how to divide responsibilities (allocate functions) between humans and technology, you'll need to consider the entire system. Defining these boundaries early ensures your analysis remains focused and relevant.

Note that HTA focuses on breaking tasks into goals and sub-goals not specific physical actions. The aim is to build a clear hierarchy that shows how complex tasks are logically structured. Each goal should be expressed as an action (using an activity verb) and the description may include performance criteria (related to quantity or quality) as well as the context in which the task is performed (including tools, environment, and materials).

Keep the structure manageable by limiting the number of immediate sub-goals under any single goal. A good rule of thumb is to group between three and ten related sub-goals under one higher-level goal. This grouping should reflect logical clusters of related activity. For instance, if several steps contribute to preparing a work surface, they might all fall under a single sub-goal titled "Prepare workspace." Note that HTA does not support single sub-goals—each higher-level goal must branch into at least two related sub-goals.

Expect to revise your analysis multiple times before it’s complete. Your first version is just a draft, it will almost always require improvements. The number of revisions will depend on how complex the task is and how much time you have. For straightforward analyses, you may need around three iterations; for more complex tasks, ten or more passes could be necessary. Each round of revision helps refine the hierarchy, clarify goals, and ensure the structure accurately reflects real-world performance.

1.2. Problem identification matrices

Problem Identification Matrices (PIMs) are analytical tools used to systematically identify mismatches between task demands and human capabilities, particularly in the context of disabilities. They are built on a detailed task analysis that breaks down a job or activity into clear subgoals, that must be achieved for the task to be completed successfully. Each subgoal needs to be described in sufficient detail to expose any potential barriers that a worker might face when attempting to achieve it. This level of detail is essential to ensure that no critical aspect of task performance is overlooked.

For every subgoal, a structured set of questions is posed to examine how different types of impairments (physical, cognitive, or sensory) might interfere with task performance. These impairments serve as a guide, helping the assessor ensure that a comprehensive range of human limitations is considered. The matrix is then constructed with subgoals listed on one axis and types of impairments on the other. This format creates a grid where each intersection represents a specific interaction between a task subgoal and a potential impairment.

At each intersection of the matrix, the assessor must determine whether a given impairment could restrict an individual’s ability to achieve the subgoal. If a restriction is identified, the severity of the problem is also assessed, ranging from potential problem to impossible barrier. This process not only highlights whether there is a problem but also provides insight into how critical the issue is and whether accommodation or redesign might be necessary.

By linking system requirements directly with human capabilities and limitations, PIMs create a clear visual representation of where task demands may exceed what certain individuals can reasonably perform. This helps designers, ergonomists, and occupational specialists make informed decisions about how to modify tasks, environments, or tools to enhance accessibility and inclusion. In this way, PIMs support proactive problem-solving and contribute to the creation of workplaces that accommodate a diverse workforce.

Figure 1 depicts a general outline of the PIM, use any of the five HTA-s in section 1.1 to test the uses of PIM.

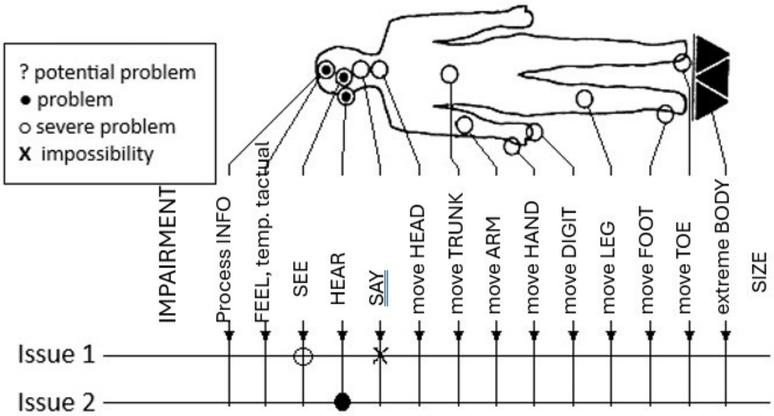

Figure 1. General outline of a problem identification matrix (modified from Koroemer 2005

1.3. Simulations

Digital human modelling software represents a class of ergonomic and simulation tools designed to replicate human interaction within virtual environments. These systems allow designers, engineers, and ergonomists to create detailed digital avatars that reflect real-world anthropometric data, enabling the analysis of posture, movement, reach, visibility, and comfort. By simulating human behaviour in 3D workspaces, digital human modelling software helps optimize product and workstation design, improve safety and accessibility, and reduce the need for costly physical prototypes. This technology is especially valuable in inclusive design, where it supports the creation of environments that accommodate a wide range of physical abilities and limitations.

HumanCAD by NexGen Ergonomics is a digital human modelling software designed to simulate and evaluate human interaction within 3D environments. It allows users to create highly customizable digital mannequins based on a wide range of anthropometric databases, including data for children, elderly individuals, and people with varying body types. HumanCAD supports ergonomic assessments tools and biomechanical modelling, making it a valuable tool for analysing posture, reach, vision, and comfort. Its modular design and compatibility with CAD formats enable seamless integration into product and workplace design workflows, particularly in industries like manufacturing, healthcare, and education.

Process Simulate Human, developed by Siemens as part of the Tecnomatix suite, is a high-end solution tailored for industrial applications. Built on the Jack platform, it offers advanced capabilities such as motion capture integration, real-time visualization, and virtual reality support. This software is particularly effective in simulating complex manual tasks and evaluating human performance in manufacturing and assembly environments. It provides detailed ergonomic analyses, including fatigue, strength, and accessibility assessments, and is deeply integrated into product lifecycle management systems. This makes it ideal for optimizing human-machine interaction and ensuring safety and efficiency in large-scale operations.

Both tools are highly applicable in designing workstations and environments for people with disabilities. HumanCAD's ability to model diverse body types and simulate reach and mobility constraints allows designers to evaluate accessibility and usability for individuals with physical limitations. It can help ensure that workstations accommodate wheelchair users, individuals with limited range of motion, or those requiring assistive devices. Similarly, Process Simulate Human can simulate the interaction of disabled users with complex machinery or environments, using motion capture and VR to test real-world scenarios. This enables engineers and designers to proactively identify and mitigate barriers, ensuring inclusive and compliant design solutions that enhance independence and productivity for all users.

More specialized digital human modelling software focuses on specific use cases, such as modelling manual material handling tasks or evacuation scenarios.

3D SSPP (Static Strength Prediction Program), developed by the University of Michigan, is a biomechanical modelling tool used to evaluate the physical demands of manual tasks and predict human strength capabilities in static postures. By inputting anthropometric data and task parameters (such as hand positions, forces, and joint angles), the software calculates joint moments, spinal loads, and strength requirements.

Pathfinder is an advanced evacuation simulation software developed by Thunderhead Engineering, designed to model the movement of people during emergency scenarios with high realism and flexibility. A key strength of Pathfinder is its ability to represent a wide range of occupant profiles, including individuals with special mobility needs. The software allows users to simulate the evacuation of people using wheelchairs or hospital beds, incorporating the presence of designated assistants who help guide or transport them to safety. This feature is crucial for planning inclusive evacuation strategies in healthcare facilities, public buildings, and other environments where accessibility is a priority. By accounting for varying movement speeds, assistance requirements, and spatial constraints, Pathfinder enables designers and safety planners to evaluate and optimize evacuation procedures that ensure the safety of all occupants, regardless of physical ability.

2. Pen paper based observational methods

2.1. Assessment of awkward postures

Ergonomic assessment of awkward postures and movements is a systematic approach to evaluating the physical strain that arises from sustained or frequently repeated non-neutral body positions. This type of assessment focuses on how such postures affect different body regions over time, with the aim of identifying risks that may lead to musculoskeletal disorders. By analysing how the body is positioned and used during task performance, the methods helps to reveal biomechanical strain and posture-related stress that might otherwise go unnoticed. It is particularly valuable in work environments where awkward positioning is a routine part of the job, providing a structured foundation for recognizing harmful patterns, and prioritizing interventions or workplace adjustments.

Postural assessment methods are primarily used to evaluate musculoskeletal risk, typically as part of a broader ergonomic analysis. Their main applications include:

- Comparing the effects of current versus modified workstation designs
- Assessing outcomes such as productivity or the suitability of equipment
- Educating workers about musculoskeletal risks associated with different working postures

The general approach behind these methods is to assess body segments individually rather than evaluating the body as a whole. This is done using simplified biomechanical and physiological principles. Each body segment is assigned a score, and scoring tables are then used to calculate an overall risk score for the entire body, indicating the level of musculoskeletal risk.

To ensure proper use of these methods, users should be trained or have sufficient familiarity with the tool. While no prior ergonomic expertise is required, competence in applying the specific assessment method is essential.

Rapid entire body assessment (REBA)

The REBA (Rapid Entire Body Assessment) method is designed to evaluate work tasks that are primarily static in nature. It is used to identify and assess musculoskeletal risks by observing a worker's posture during task performance. Observation can be carried out in real time, or by reviewing photographs or video recordings of the task.

The assessment involves scoring various body segments (such as the neck, trunk, and limbs), as well as evaluating load/force, coupling (the interaction between the worker and the object or tool), and activity factors. These values are recorded on a structured score sheet here.

When scoring the upper limbs, the choice between the right or left arm typically depends on which side is more visible during observation. However, both sides may be evaluated, with the higher-risk score carried forward in the assessment process to ensure a conservative estimate of risk.

The scoring process involves a sequence of look-up tables:

- Table A is used to generate SCORE A by combining trunk, neck, and leg posture scores.
- Table B is used to generate SCORE B by evaluating arm and wrist postures.
- Additional points are then added based on the load or force involved in the task, including extra consideration for sudden or rapid force application (e.g., catching a falling object).
- The coupling score, which assesses how effectively the worker can grasp or interact with the object, is also added at this stage. It uses four qualitative levels (good, fair, poor, and unacceptable) to describe the quality of this interaction, whether it involves the hands or other body regions.

SCORE A and SCORE B, along with the load and coupling adjustments, are then combined using Table C to produce SCORE C. At this point, an Activity Score is added to account for: i) static postures held by one or more body parts, ii) repetitive small-range movements, iii) large or frequent changes in posture or iv) tasks performed on an unstable base of support.

The final result is a REBA SCORE, which is interpreted using one of five Action Levels. These levels indicate the urgency with which corrective action should be taken to reduce or eliminate the observed ergonomic risks—from no action needed to immediate intervention required.

Key Indicator Method for assessing and designing physical workloads with respect to Awkward Body Postures (KIM-ABP)

For tasks of a more dynamic nature, where work postures change frequently and are not easily captured by static analysis, less detailed but broader methods are appropriate. The KIM-ABP (Key Indicator Method for Awkward Body Postures) is specifically designed to assess and guide the design of physical workloads involving repetitive or sustained awkward postures.

The method focuses on sub-tasks that include physically strenuous postures required for the work process. Awkward body postures are defined as non-neutral positions that are held either continuously for one minute or more, or repeatedly for durations of 10 seconds or more. These postures are considered problematic only if they cannot be interrupted or compensated by relaxed positions—such as upright standing, variable seated positions, or slightly altered relaxed postures that do not interfere with task performance.

KIM-ABP recognizes that awkward postures can affect the body simultaneously and independently across three main areas:

1. The lower and upper back
2. The shoulders and upper arms, including the neck
3. The knee joints and legs/feet

The assessment follows a three-step process:

- **Step 1.** Determine time rating points for sub-tasks that involve awkward postures, based on how long and how often specific posture classes occur.
- **Step 2.** Evaluate and score additional indicators, which include the nature of the posture itself, unfavourable working conditions (e.g., cramped spaces, restricted movement), and further working conditions (such as temperature, lighting, or personal protective
- **Step 3.** Calculate and interpret the final risk score, which indicates the severity of the physical workload and guides whether and how urgently preventive measures are needed.

Because of the dynamic and variable nature of tasks evaluated with KIM-ABP, the method requires numerous observations. These observations help to estimate the proportion of time (e.g., ¼, ½, ¾, or more than ¾ of the task duration) that a worker spends in a particular posture class within each sub-task. All data are recorded on a structured score sheet here, which ensures consistency and allows for comprehensive risk analysis.

2.2. Assessment of manual material handling

Manual material handling is a broad term that encompasses a range of tasks involving the physical movement of objects, such as lifting, holding, carrying, pushing, and pulling. These activities place physical demands on the body and can lead to musculoskeletal disorders if not properly managed.

However, not every instance of moving a load needs to be assessed as manual material handling. In general, ergonomic risk assessments for manual material handling are warranted when the handled weight is 3 kg or more. Tasks involving objects weighing less than 3 kg may still pose risks, particularly to the upper limbs (e.g., arms, wrists, shoulders), but these are typically assessed using ergonomic methods tailored to repetitive or fine motor tasks, rather than manual handling tools.

It's also important to note that manual material handling assessments apply to workers who do not have existing back or musculoskeletal impairments. Workers with pre-existing limitations should be evaluated by qualified healthcare or ergonomics professionals, as their needs may fall outside the scope of standard assessments and require individualized accommodations or medical guidance.

The Health and Safety Executive (HSE) has developed user-friendly tools to help reduce the health risks associated with manual material handling.:

- The Manual Handling Assessment Charts (**MAC**) tool, designed to assess tasks involving lifting, lowering, carrying, and team handling.
- The Risk Assessment of Pushing and Pulling (**RAPP**) tool, intended for evaluating pushing and pulling tasks.

Both tools follow a similar structure and assessment approach. They guide the assessor through an evaluation of several key risk factors, using clearly structured templates provided within the tools. For each risk factor (such as load weight, posture, grip, or environmental conditions), the assessor assigns a score and a colour code that indicates the level of risk (e.g., low, medium, high, or very high).

While the total scores do not correspond to specific mandatory action levels, the colour-coded ratings help prioritize where interventions are most urgently needed. This makes the tools especially useful for screening and prioritization of manual handling risks in the workplace.

Importantly, both the MAC and RAPP tools are designed for use by non-specialists. To support appropriate use, the score sheets included in each tool's manual feature checklists that may flag complex situations where the involvement of a professionally trained ergonomist is recommended.

You can access the instructions and score sheets for the MAC tool here and for the RAPP tool here.

2.3. Assessment of repetitive tasks

This type of physical workload involves uniform, repetitive motion and force exerted by the upper extremities, typically through the use of instruments, small tools, or hand-guided machines when necessary. These tasks are usually performed in a stationary position, either sitting or standing. The nature of the work involves either processing or modifying a work piece or handling and moving small objects repeatedly throughout the workday.

Common examples of such tasks include assembly work, such as assembling electrical appliances, as well as soldering, sewing, sorting, cutting, cashiering, pipetting, microscope work, and other activities that require fine motor control or repetitive upper limb actions. Workers may also perform actions such as joining parts, turning or shifting objects, pressing controls, lifting or holding small items, relocating components, or wrapping materials. In many of these roles, the objects handled are relatively light, typically weighing less than 3 kilograms. Often, the physical strain comes not from the weight of the object, but from the repetitive use of the arms and hands themselves. In such cases, the mass of the upper limbs contributes significantly to the musculoskeletal load.

Despite the repetitive nature of these tasks, the risk of developing repetitive strain injuries may be negligible under certain conditions. If the task is not cyclical, or if the task includes cycles but the demands are primarily sensory or cognitive with only marginal physical involvement of the upper limbs, then the likelihood of strain-related injury is minimal.

To support the assessment and prevention of health risks related to repetitive upper limb tasks, the Health and Safety Executive (HSE) has developed the Assessment of Repetitive Tasks (**ART**) **tool**. This tool, similar in structure and procedure to the MAC and RAPP tools, is designed for practical use by non-specialists with basic training. The ART tool guides the assessor through the evaluation of several key risk factors, including the frequency and repetition of movements, the level of force applied, and the presence of awkward postures involving the neck, back, shoulders, arms, wrists, and hands. Additionally, the tool takes into account contextual factors such as the overall duration of the task, the frequency and adequacy of breaks, and the work pace.

The ART tool uses structured score sheets and a colour-coded system to identify risk levels, which helps prioritize tasks for intervention. It provides a practical and accessible means of identifying repetitive strain risks and supporting ergonomic improvements in a wide range of work environments. The instructions and score sheets for the ART tool are available here.

2.4. Assessment of workload

The NASA Task Load Index (NASA-TLX) is a subjective workload assessment tool designed to evaluate the mental and physical demands of specific tasks, rather than entire jobs. It is widely used in both research and applied settings to measure how individuals experience workload during short-term or well-defined activities. This method helps identify aspects of a task that contribute to perceived strain, cognitive overload, or inefficiency, thereby supporting the design of more user-friendly and sustainable work processes.

The fundamental idea of NASA-TLX is that workload is a multidimensional construct that cannot be captured by a single factor. Instead, it is assessed through six distinct dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration level. Each of these dimensions represents a specific component of the individual's experience while completing the task. For example, mental demand captures the degree of cognitive effort required, while temporal demand reflects the pressure associated with time constraints. The perceived success in performing the task is also included as a measure of performance, judged by the individual rather than external metrics.

The assessment process typically involves two steps. First, participants are asked to rate each of the six workload dimensions on a scale from 0 to 100, based on their experience with a particular task. Second, a weighting procedure may be conducted in which participants compare each pair of dimensions and indicate which contributed more to their sense of workload. These pairwise comparisons are used to calculate individualized weights, which are then combined with the raw ratings to produce an overall workload score. Although the weighting step is optional in practice, it adds nuance by highlighting which factors are most influential for a particular user or context.

One of the key strengths of NASA-TLX is its flexibility and ease of administration. It can be applied across a wide range of domains. Because it is task-specific, the tool is particularly well-suited for comparing variations of the same task, assessing the impact of workplace accommodations or tracking changes in perceived workload over time.

It is important to emphasize that NASA-TLX is intended for evaluating specific tasks, not entire jobs. For example, it can be used to assess the workload associated with scanning and bagging items, processing customer payments, or restocking shelves, but it is not suitable for evaluating the overall demands of working as a supermarket cashier. This distinction ensures that the results are both meaningful and directly applicable to task redesign or workload management within clearly defined operational contexts. To use NASA-TLX effectively, it is therefore advisable to conduct a task analysis beforehand, ensuring that the task being assessed is clearly defined and distinct.

3. Direct measurements

As previously mentioned, different ergonomic assessment methods serve distinct purposes. Analytical methods are typically used to predict future demands, such as those associated with the design of new work systems or tasks. In contrast, observational, pen-and-paper methods are useful for identifying existing problems in current work situations, helping to detect risk factors that may contribute to inefficiency or injury. Direct measurement techniques can serve both functions: they can enhance our understanding of issues in actual work environments and provide quantitative data that can inform task or workplace design.

This is particularly relevant when applying the ergonomics for one approach, where the focus is on optimizing the fit between a specific person and their work environment. In such cases, collecting data on an individual's physical or sensory capacities becomes essential. These measurements can range from low-tech methods, such as assessing visual acuity, measuring static reach, eye level, or elbow height, to high-tech techniques, such as eye tracking, muscle endurance testing, motion capture, or recording the trajectories of body movements.

Direct measurement techniques can also serve as an objective and unbiased means of determining whether a workstation or task setup is suitable for a particular worker as it is, or whether accommodations or modifications are needed before the individual begins the job. This type of assessment is particularly valuable when making decisions about workplace accessibility, job matching, or task readiness, especially for individuals with specific physical or functional limitations.

As with other ergonomic evaluation methods, this approach benefits significantly from a well-prepared task analysis and clearly defined performance criteria, which may be established either analytically or through experimental trials. These criteria help define what successful task performance looks like and allow assessors to compare the worker's abilities to the actual demands of the job.

For example, in the case of a waiter position, motion capture technology could be used to evaluate whether a worker can carry food and navigate the dining area without excessive instability or risk of spillage. Such data can inform whether the task can be performed safely and effectively without adjustments, or whether ergonomic interventions (such as tray redesign, route modification, or training in movement techniques) are needed to support successful job performance.

Direct measurement techniques come with several practical challenges that must be considered before implementation. These methods typically require careful calibration, routine maintenance, and specialized technical expertise to ensure that the data collected is accurate and meaningful. Interpreting the results often demands a strong understanding of biomechanics, human movement analysis, and the specific measurement technology being used. Any errors in calibration or data processing can compromise the reliability of the assessment, making the entire process less effective.

Another significant limitation is the high cost of the equipment and software required for direct measurement. Systems such as motion capture suits, force platforms, or electromyography devices can be prohibitively expensive, especially for smaller organizations, short-term projects, or environments where large-scale assessments are needed. This financial barrier is one of the main reasons why pen-and-paper observational methods, which are simpler, more accessible, and cost-effective, are more commonly used in routine ergonomic assessments. Although observational methods may lack the precision and objectivity of direct measurement, they offer a practical balance between usability and insight in many workplace settings.

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