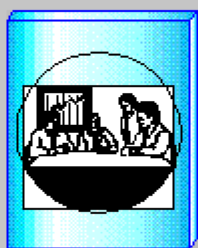
Chapter 2
ESTABLISHING A HUMAN FACTORS/ERGONOMICS PROGRAM

2 Establishing A Human Factors/Ergonomics Program



Author: Colin G. Drury

Quote: " Successfully implementing a human factors program requires that hangar-floor teams have the flexibility to choose solutions that fit well with local conditions. "

INTRODUCTION

A number of different approaches can be used to introduce human factors methods and concepts into an organization. These approaches differ with regard to the degree of continuity and integration with other organizational procedures. For example, one way to introduce human factors is to address each problem area as a specific, isolated task. As each new problem area is identified, by whatever means, then it is analyzed and "solved" by an *ad hoc* team put together for the occasion.

A slightly more integrated approach might be to create a human factors focus within each maintenance department. This person or group is then responsible for taking a consistent approach to human factors issues within the department. At the top end of the integration scale, human factors can be programatically embedded in the overall maintenance organization.

As human factors practitioners, we take the position that any approach to implementing human factors methods within an organization can be beneficial. However, some approaches are more efficient than others. Consider the common operational practice of making engineering changes. Obviously, each engineering change could be implemented on an case-by-case basis. This would probably result in re-inventing procedures for each change. However, organizations have found that a consistent engineering change *process*, implemented on a company-wide basis, is much more efficient and easy to control.

Human factors should be viewed in the same light as other initiatives that affect fundamental work practices, such as Total Quality Management (TQM).[1] Human factors is much more successful when completely integrated into the work environment.

You do not have to implement an organization-wide, full-blown human factors program before you can enjoy the benefits of human factors methods. Human factors practitioners typically combine, or integrate, the best features from both implementation extremes. Moving from having no human factors program to having human factors be natural and pervasive requires central planning, integration, and grass-roots project support. In manufacturing this has meant forming small teams on the shop floor and supporting them with a number of formal [2] or relatively informal [3] integrating activities.

Successfully implementing a human factors program requires that hangar-floor teams have the flexibility to choose solutions that fit well with local conditions. An integrated approach eliminates duplication of effort, while maintaining local teams' autonomy and flexibility. This implementation process has much in common with other highly-integrated, team-based programs such as **TQM**. An integrated effort is the most rapid, complete way to initiate a human factors program that becomes part of the organization's normal operating procedure -- not just a fad.

As this *Guide* repeatedly emphasizes, embedding human factors principles and methods provide benefits to a maintenance organization. Since the goals of human factors are worthwhile, we should use the best means available to implement a program. To derive the most benefit from human factors, an organization must ensure that the program is implemented properly and completely.

BACKGROUND

Organized human factors programs are new in aircraft maintenance and inspection. However, a number of existing human factors programs can be used as a basis for maintenance operations. Human factors is not new in flight operations, or in manufacturing and service industries. It has a long history, often under the more European term *ergonomics*, rather than the North American term *human factors*. In this section, we briefly review the history of ergonomics/human factors and give examples of existing human factors programs in aviation maintenance environments.

Human factors engineering for flight operations dates back to World War II.[4] During that period, rapidly improving technical systems exposed the fallacy of ignoring the person, i.e. the pilot, in the system. System-induced human errors, such as misreading altimeters or mis-selecting cockpit controls, were reduced or eliminated through better pilot-cockpit interface design.

Basic human factors techniques were developed in the 1940's and 1950's. Analyzing errors helped engineers focus on designing for the human worker. Task analysis provided a systematic procedure for understanding and predicting operator-system mismatches that could lead to errors.[5] Quantitative research on human physical and mental capabilities led to development of a performance database and specific design principles.[6] The spectacular reduction of aircraft accidents over the last four decades has been at least partly due to the systematic reduction of pilot error with human factors design.

Manufacturing industries have benefited from human performance knowledge gained in military and civil aviation. Human factors programs in major domestic and international companies have applied human factors design data to industrial tasks, including the following:

- process control, e.g., steel plants and nuclear power stations[7]

- human-computer interaction, e.g., modern office design and integrated manufacturing cells[8]
- manual tasks with high injury potential, e.g., materials handling and repetitive assembly operations.[9]

Elements of all these tasks exist in the aviation maintenance and inspection environment. Typical maintenance tasks include diagnosing faults in avionics systems, using computer-based **NDI** equipment, heavy lifting during component removal and installation, and highly-repetitive tasks in brake or engine shops.

Human factors is used in maintenance and inspection task design in a number of ways. Incorporating human models in computer-aided design (CAD) systems allows aircraft to be designed so they are easier to maintain. The use of CAD in the Boeing 777 program has been widely publicized.[10] At least one airline is using a human factors audit program as part of its regular **QA** audit to detect error-prone situations.[11]

Other airlines have successfully implemented programs to enhance human-human communication in maintenance, generally known as Crew Resource Management or Maintenance Resource Management.[12] (See **Chapter 16**) One airline has developed an on-line computer system for documenting and analyzing human errors in maintenance.[13] Another has implemented an integrated human factors program in inspection and maintenance after studies highlighted inspection difficulties in restricted aircraft spaces.[14]

Experience from aviation and manufacturing industries shows that a successful human factors program must be based on a small set of essential elements:

- *Technical knowledge* of tasks to be performed and of human factors engineering principles and data.
- *Analytic tools*, such as task analysis or error analysis, to determine potential mismatches between people and their jobs.
- *Design tools* to move from problem diagnosis and documentation to feasible solutions.
- *Commitment* by management, by the workforce, and by the staff to the goals and processes of the human factors program. Typically, this requires having a program champion high in the organization and having effective, multi-disciplinary teams to perform the work.

ISSUES AND PROBLEMS

Human factors programs address a number of issues in the aviation maintenance workplace.

The details of these issues vary widely from company to company and from workplace to workplace within each company. However, the general factor that ties all these issues together is a basic lack of fit between workers and their jobs, tasks, or workspaces.

The Aloha accident (cited in **Chapter 1**) precipitated much interest in human factors in maintenance and inspection. However, there are many other known mismatches between workers and their jobs. Any worker/job mismatch can affect job performance, worker well-being, or both. *Performance* means the speed and accuracy with which a task is carried out. Mismatches appear as delays, missed deadlines, or errors. *Well-being* refers to worker health and safety. Mismatches manifest themselves as stress, job dissatisfaction, or injuries.

Table 2-1. Typical human-system actions and problem solutions

Function	Typical Actions	Changes to Workers	Changes to the System
Initiate	Gets workcard, reads, understands, calibrates equipment	*Training in **NDI** calibration	*Re-design workcards **HF** in calibration of NDI equipment. Feedforward of expected indications
Access	Moves to area to be inspected, carrying needed equipment	*Training in area location	*Better support stands Better location aids Improved locations of NDI equipment
Search	Scans area either visually or using equipment; stops for indications	*Training in visual search	*Improved task lighting Optical aids Improved templates
Decision	Makes decision on whether or not an indication exceeds standard	*Decision training	Access to standards Decision job aids *Improved feedback to inspection
Response	Writes non-routine repair (NRR) form, marks indication as defect	Writing skills training	Improve fault marking Hands-free defect recording
Repair	Performs work specified on NRR		
Buy Back	Recheck work and sign off, if it meets standards		

Typical inspection problems

As part of the **FAA**/Office of Aviation Medicine's project on human factors in maintenance and inspection, we undertook an ergonomic analysis of inspection activities to determine how human factors could improve aircraft inspection. We analyzed different inspection tasks at a number of sites to derive a generic inspection function list. The review provides a useful structure for determining problems and issues; it can be extended to maintenance and inspection activities at any site.[15]

We examined each inspection function (see **Table 2-1**), for worker/job mismatches. For each mismatch, we considered two interventions, or "fixes":

1. Fit the worker to the task. Use selection, placement, motivation, and training to give the worker capabilities to perform the task.
2. Fit the task to the worker. Change hardware, processes, or procedures to allow the worker, with his or her present skills, to perform the task.

Table 2-1 shows the human factors changes we proposed after the study described above. The changes that have been tried are marked with an asterisk (*). Typical problems in inspection include the following:

- Workcards with layout, typography and poor use of graphics contributing to misunderstanding and error.
- Interface design of **NDI** equipment not following good human factors practice and leading to calibration errors.
- Faulty training design for visual search. This is a perceptual motor skill and, as such, difficult to communicate verbally or with written instructions.
- The poor lighting/visual environment in hangars makes it difficult to bring the necessary amount and quality of light to the defect detection process, leading to missed defects.

While we proposed a number of system changes for each type of worker/system mismatch, training is the **only** practical option to change workers. This underscores the importance of training in the aviation environment. For inspection tasks in particular, the attempt to develop valid worker selection tests has been unfruitful.

While training is important in the process of adapting people to jobs, it also has an ongoing cost. Also, when a job is poorly designed for a person, training costs are much higher. The seemingly common-sense approach of adapting a person to a job is really an expensive prospect, allowing a person to adapt only within the confines of the job as it was designed. A much better, less-expensive approach is to first fit the task to the person and **then** train for performance with the improved design, i.e., then fit the person to the revised task.

General maintenance problems

Maintenance, as opposed to inspection, shares problems such as those with workcards and lighting. Specific maintenance problems include the following:

- Awkward postures due to restricted spaces and unsuitable support stands (**Figure 2-1**) leading to postural fatigue and errors.

- Heavy and awkward lifting and movement of components, particularly around structural obstructions (**Figure 2-2**). This leads to component and structural damage, as well as to soft tissue injuries.
- Controls on access equipment, such as cherry pickers, which do not follow good human factors practice (**Figure 2-3**). Such poor control design often results in contact between the equipment and the aircraft structure.
- Lack of tool counting and checkoff procedures (**Figure 2-4**), allowing for the potential of leaving tools inside structures when work is complete.
- Lack of conspicuous visual indicators of correct closure (**Figure 2-5**), leading to failure to close access hatches completely after maintenance.

Although these problems can be addressed piecemeal, a planned, integrated approach would solve them more efficiently and effectively. Human factors methods common to most maintenance and inspection problems can be taught, practiced, and utilized as an organization builds its expertise.

Figure 2-1. *Example of awkward posture due to a restricted workspace (Drury, 1994)*

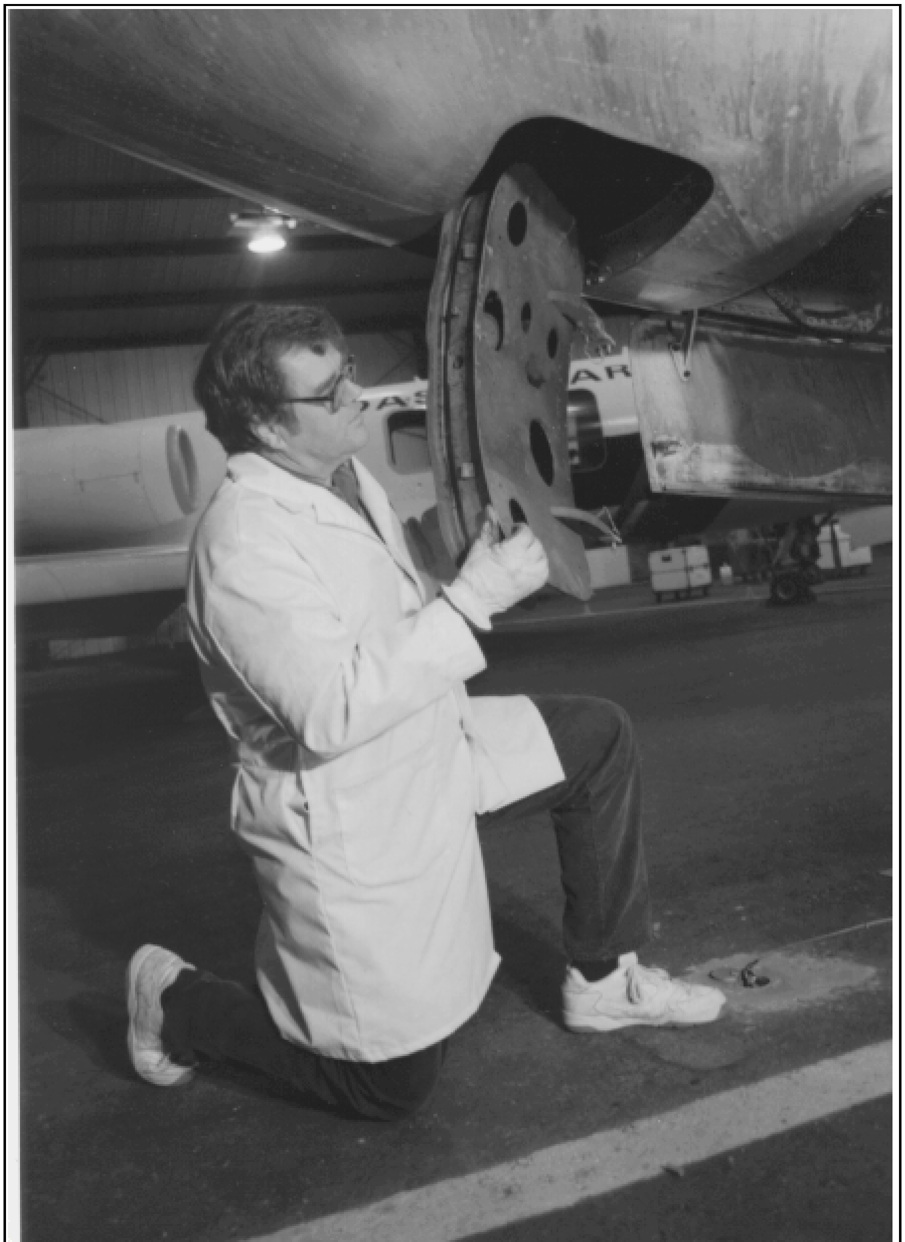


Figure 2-2. *Example of awkward lifting (Drury 1994)*

Figure 2-3. *Poor control/display relationships on access equipment (FWD is towards operator, REV is away from operator; operator cannot see markings anyway!) (Drury, 1994)*

Figure 2-4. *Tool left in an aircraft structure (Drury, 1994)*

Figure 2-5. *Example of cover with closure markings difficult to see (upper closers not fully fastened) (Drury, 1994)*

REGULATORY REQUIREMENTS

There are no specific regulatory requirements for implementing human factors programs in aircraft maintenance facilities. In fact, there are no regulatory requirements for implementing human factors programs anywhere. However, many organizations have discovered that integrating human factors principles and methods into their operation can reduce costs and increase safety and productivity.

The **FAA** is currently reviewing the training requirements for **AMT**s, with an eye toward including certain human-factors-specific knowledge in AMT licensing standards. It is also possible that human factors course work will be embedded in the AMT training requirements. (see **Chapter 7**)

As of this writing (early 1998), there are two emerging sets of standards related to implementing human factors/ergonomics principles in the workplace. Neither of these efforts relates directly to the aviation maintenance environment. Both programs - one from **ANSI**[16] and one from **OSHA**[17] - are specifically designed to reduce only worker injury and are concerned mainly with musculo-skeletal injuries, such as cumulative trauma disorders and back injuries (see **Chapter 1**). These programs apply to jobs that are highly repetitive or involve using one's body to apply force.

An example of a repetitive task in the aviation environment is disassembling and rebuilding components like brakes or seats. Applying force with the body includes lifting, lowering, carrying, pushing, and pulling. Examples in the aviation environment include installing or removing heavy or awkward equipment and moving support stands into place.

Program elements in both standards are useful for aviation maintenance and inspection. They include specifics for surveillance of injuries and potential injuries, detailed job analysis, redesign of workplaces, and medical follow-up for injured workers.

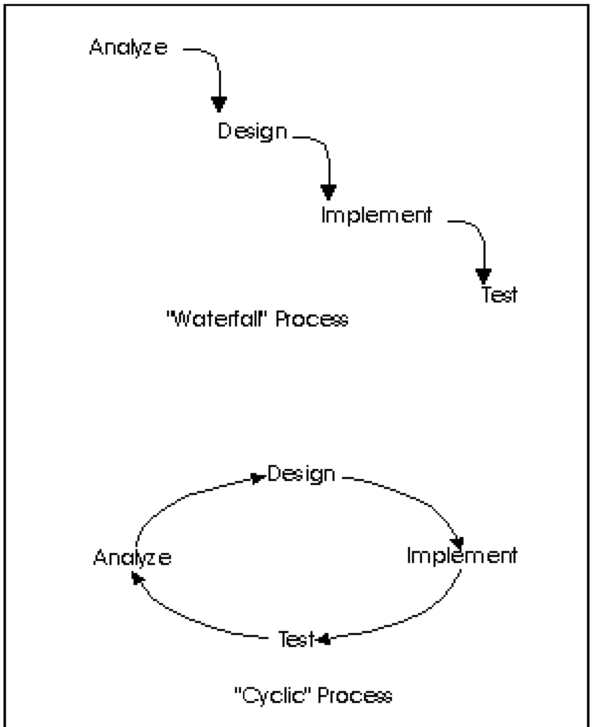


Figure 2-6. *Waterfall and cyclic design processes*

CONCEPTS

A core set of concepts apply to implementing any human factors program. We briefly describe each core concept below. As with other chapters in the *Guide*, these concepts can be applied to various specific human factors issues and problems.

Analyze/Design/Measure

Implementation cannot stop when a human factors program is introduced to the hangar floor. After a program is in place, workers' performance and well-being should be systematically measured to allow designers to evaluate its effectiveness and to form the basis for a continuous improvement process.

This concept is often described as a "cycle" in which various analysis, design, implementation, and measurement activities are done repeatedly - as long as the system remains in place. **Figure 2-6** shows how the cyclic process differs from the once-through, "waterfall" design process.

Bottom-Up

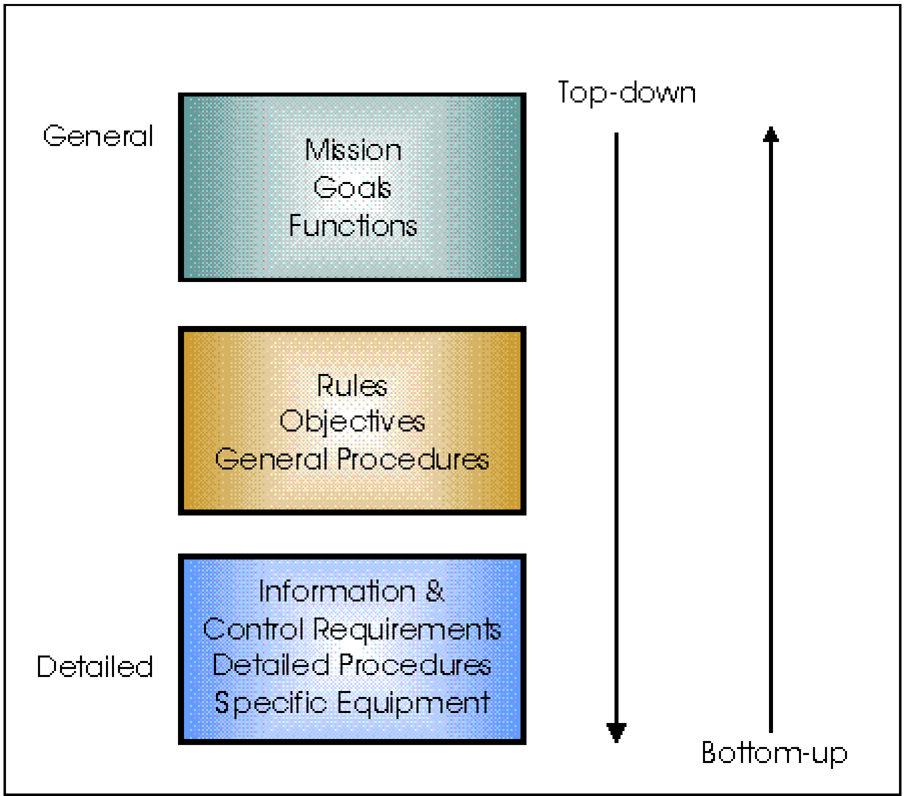


Figure 2-7. *Hierarchy of system detail*

As one might suspect, bottom-up activities are performed by looking, first, at detailed levels of the hierarchy shown in **Figure 2-7** and then generalizing to higher levels. An example of a bottom-up process is choosing a new piece of diagnostic equipment without first considering how it fits into the overall goals or functions of the maintenance organization. Suppose the new equipment requires technicians to interpret a complex display, but our new maintenance philosophy is to eliminate as much complex interpretation as possible. In this example, the bottom-up process would cause a mismatch between organizational goals and our purchase decision.

Human factors practitioners typically start with a **top-down approach** to ensure that higher-level goals are met. When implementing human factors programs in organizations, however, some bottom-up activities are useful. These are discussed in the **METHODS** section of this chapter.

Continuous Improvement

Industry around the world has benefited from the concept of incremental continuous improvement. Continuous improvement recognizes two facts of life in the real world. First, the initial design of any system is likely to be "improvable." The design goal of "getting it right the first time" is never fully achieved in practice.

Second, every system changes over time. Even a well-designed system using human factors techniques must be improved to meet changing operational needs. Even if operational needs don't change, technological advances in system components and design techniques often require updates and improvements to the original system.

Data-Driven

As a technical discipline, human factors is based on measurable, repeatable data, not on unsubstantiated opinion. Although strongly-held opinions are common in every workplace, solid data will eventually overcome prejudice. Engineers on design teams need sound technical data about human capabilities and limitations to provide a defensible design.

Tasks that rely on objective data include designing physical workspaces to accommodate the range of sizes in the user population and ensuring consistent interfaces throughout the hangar to minimize errors as workers move among tasks.

Proactive Analysis

Proactive implies taking action before some event occurs. Human factors principles are often applied only after someone is injured or property is damaged. However, human factors programs promote systematic, proactive job analysis. This involves valid analysis methods, such as task analysis, that identify worker/system mismatches before dramatic errors or injuries occur. Proactive analysis eliminates "headline" incidents while improving general system efficiency and workers' well-being.

Systematic Design

Human factors engineers break down a system into its various categories of components, designing each element to interface well with others. Component categories are assigned names that depending on the particular framework, or model, used. One model, known as TOME, defines component categories as Task, Operator, Machine, and Environment.[18] The International Civil Aviation Organization (ICAO) uses the **SHEL** model (see Chapter 1, **Figure 1-2**). In this case, component categories include Software, Hardware, Environment, and Liveware.[19]

Regardless of the model, the intent is to support a systematic framework for design, implementation, and evaluation.

Top-Down

This term describes a hierarchy of detail where the most general (least-detailed) category is located at the top: the least-general (most-detailed) category is located at the bottom. The general form for this hierarchy is shown in **Figure 2-7**. In practice, any activity conducted "top-down" first examines the system's most general goals. After the general goals are identified and agreed upon, more detailed system functions are defined.

A common aviation example of a top-down activity is an airline's choice of a new airplane. Normally, general questions are asked (and answered) first: What is our market? What city-pairs do we need to serve? How many legs will most of our flights have? What are our fuel economy and maintenance goals? Answers to these questions form goals and functional requirements. Only after defining general elements does an airline look in earnest for an aircraft satisfying its high-level requirements.

METHODS

This chapter is unique in the *Guide.* Whereas other chapters describe various methods related to the chapter topic, this chapter is devoted to performing a specific activity, i.e., to implementing a human factors program. The method we describe here has been developed specifically for airline maintenance. This method has also been used to implement human factors programs in manufacturing companies.[9]

The method we propose uses a task force that develops human factors expertise, determines and justifies the need for human factors intervention, designs and evaluates solutions, and finally implements the preferred solution(s). Our method is not the only one. Other methods have been used successfully both in manufacturing and in the maintenance hangar.

A second method is to use management-initiated solutions for a predefined problem. In this case, broad workforce surveys justify the need for change. Human factors professionals design a solution to be evaluated with user trials and workforce surveys. Such a management-led strategy was successful in redesigning workcards, improving computer-based training systems, and developing a better shift-change log.

Workers lead a third noteworthy method by meeting in focus groups with a human factors facilitator to determine problems to be tackled. Ad-hoc workforce groups undertake design or redesign and evaluate the revised design with survey or focus group input before management authorizes implementation of the change. This approach has been successfully used in redesigning the maintenance logbook.

The best approach is the one best fitting the needs of everyone concerned with hangar operations. We advocate the Task Force approach in the *Guide* because it ensures that workers, managers, and staff develop human factors expertise and because it provides a built-in implementation mechanism.

The method consists of seven steps to provide a detailed plan of action. These steps are listed in **Table 2-2** and described in subsequent sections. Most steps in the method require some professional support from human factors practitioners, at least in beginning stages. Steps requiring professional human factors support are prominently noted. With this method, introducing human factors into an aircraft maintenance and inspection organization can be systematic, efficient, and self-sustaining.

Table 2-2. Steps required to implement a human factors program.

Step	Description
1	Establish the mission and structure of the program.
2*	Form a human factors task force.
3*	Train the task force.
4*	Select and analyze various jobs.
5*	Identify problems and develop solutions.
6*	Reanalyze job changes.
7*	Transfer human factors technology.

*These steps require at least some support from professional human factors practitioners.

Step 1-Establish Mission and Structure

Effective organization-wide action must be carefully designed. This is especially true for the multi-site operations typical of large airlines and repair organizations. There must be a committed corporate-level champion, as well as local champions at each site. Champions are often, but not exclusively, senior managers. **AMT**s and staff members also assume this role. A central (corporate) coordinating group typically facilitates the formation and work of on-site task forces. As a first step, each site-level task force should write a mission statement, acceptable both to themselves and to the corporate group. This helps the group remain focused as work progresses.

Step 2-Form HF Task Force

Each site should have a small task force composed of **AMT**s, supervisors, human factors engineers, and other company technical people. Wide representation on the task force will help ensure that a program is actually implemented after the analysis and design efforts are complete. Effective task forces have **visible** support from both corporate and site management.

This step requires the presence of one, or more, persons with human factors knowledge at both the corporate and local task force levels. The same human factors professional can conceivably perform all these roles on a time-sharing basis.

Step 3-Train Task Force

Each task force needs to understand basic human factors concepts to be effective. Task forces require training on human factors principles and methodology, preferably in short seminars that stress applications in their work environments. Appropriate and effective training should be provided by a human factors professional. This *Guide* offers a good basis for task force human factors training. Each task force also needs to be trained in company-specific operational methods so they can create and implement effective solutions.

Step 4-Analyze Jobs

Steps **4**, **5**, and **6** form a design cycle. A complete design cycle includes analyzing particular jobs, designing solutions to any serious human factors problems, implementing solutions, and reanalyzing the jobs for further human factors changes. A human factors professional should be involved in this process, at least for the first few design cycles. Subsequent professional help should be required only when a task force encounters a novel design task not described in this *Guide*.

A task force must select a number of different jobs to cover the range of human factors issues in the site's inspection and maintenance operations. Selections probably include jobs with key human-error potential. For example, candidate jobs contain elements such as awkward or fatiguing postures, interaction with different computer interfaces, and a sub-optimal visual environment.

Using the job analysis technique described below, the task force should analyze a wide range of jobs to determine the need for human factors improvement. Job incumbents should be closely involved in the analyses of their jobs.

Step 5-Design Solutions

In this step, the task force generates solutions to the problems they have identified in the previous steps. Ideally, solutions should be developed using the company's existing procedures. However, using existing procedures can have both positive and negative consequences.

On the plus side, existing procedures increase the chances that solutions can be implemented in the real workplace. The down side is that the existing procedures are probably a contributing factor to the current state of affairs.

It is important that middle- and upper-level managers understand their roles in fostering the current work environment (in which the task force's analysis has identified human factors problems). At this step, task force members select alternatives and make presentations to financial decision-makers. Financial justification is provided where it is appropriate for particular solutions.

Step 6-Reanalyze Changes

As jobs change to reflect the task force's solutions, the job analysis step is repeated. Re-analysis shows whether the task force's solutions are effective. The task force develops tools for measurement, such as an audit program. This feedback allows the task force to move confidently on to other jobs in the company.

Step 7-Transfer Technology

During the preceding steps, human factors professionals train the task force so they can effectively recognize and apply human factors principles during their analyses. The assumption is that the task force will diffuse this knowledge throughout the site.

The task force needs to monitor this transfer of technology and be prepared to provide human factors awareness training for others, including managers and workforce throughout the site. Although a human factors professional should supervise the technology transfer process, training for subsequent task force members at each site is more effective when existing task force personnel provide it.

READER TASKS

Typically, this section of each chapter describes which tasks readers can undertake and which tasks should be left to professional human factors practitioners. However, successfully implementing a human factors program requires the active participation of corporate and site managers, of inspectors, of **AMT**s, and of support people. Therefore, readers need to be involved in **all** of the tasks listed in the preceding section.

The procedure outlined in this chapter is designed to require relatively brief professional human factors input. It is important to use a human factors professional when first setting up the program and during the first cycles of task force activities. After that, it should be possible for each task force to continue using the skills and knowledge it acquired with only periodic monitoring by a human factors professional.

In the following **GUIDELINES** section, we identify when and where a human factors professional should be used. Sometimes, a task that can be completed without a professional practitioner requires a person with fairly broad knowledge of human factors principles and techniques.

Our ultimate aim is to have the reader, who should also be a task force member, direct all the task steps. Then professional assistance will be required only when the task force encounters new or unusual human factors problems or when it wants to expand its areas of expertise.

GUIDELINES

The following guidelines are keyed to the implementation steps described in the **METHODS** section. They are based on experience in manufacturing and aviation maintenance domains.

Step 1-Establish Mission and Structure

This step is the foundation for all later work related to implementing a human factors program. Without strong leadership, a clear mission, and an appropriate structure within the company, the odds of implementing a successful human factors program are quite low.

Establish Leadership

Although implementing a human factors program is a team effort, each team must have a strong, committed leader. The first task is to find a champion for the corporate team and for each local task force. A suitable champion is a person who holds a senior position and commands the respect of other team members. The champion's senior position helps ensure that decisions are made and implemented. The champion must also have an understanding of and enthusiasm for a human factors program.

Having an executive mentor for each human factors team or task force ensures that human factors issues are addressed efficiently. Strong leaders also keep teams on track and do not let them drift into inactivity or into activities unrelated to their mission.

Develop a Mission Statement

Many companies have procedures for forming and running task-oriented teams. The procedure usually includes writing a statementof mission and objectives. The mission for a typical corporate human factors team is to coordinate task force activities across sites and to ensure that corporate program goals are achieved. At the task force level, a suitable mission would be to implement human factors improvements across all jobs at the site.

A Mission Statement must reflect both the needs of the entire organization and the specific requirements of task force members. Each group should periodically compare its activities with its Mission Statement to ensure that it maintains focus. **Table 2-3** is an example of a Mission Statement.

Table 2-3. Typical Mission Statement and specific objectives for a Human Factors Task Force.
The Human Factors Task Force will apply human factors techniques within No. 3 bay to reduce the risk of maintenance and inspection errors and of personnel injuries.
Specific objectives for Fiscal '95 are to audit twenty tasks, to analyze the worst five of these tasks, to make design recommendations on the five tasks, and to implement four.

Step 2-Form Human Factors Task Force

The people who form the Human Factors Task Force(s) do the actual work of implementing a human factors program. To simplify subsequent discussions, we refer to "task force" as singular, even though a company may have more than one task force. Selecting the properpeople for the task force is critical for its success. A professional human factors person can be of great help in this regard.

It is important to remember that a human factors program is an ongoing endeavor, not a one-shot affair. The task force formed to implement the initial program will be the nucleus of the continuing human factors effort.

Task Force Composition

An ideal task force includes representatives from the following three job categories:

- workers
- managers
- technical specialists.

Workers include **AMT**s, inspectors, shop operators, and cleaners. Managers can include site managers, maintenance managers, and shift supervisors. Technical specialists include human factors practitioners and experts in areas such as quality assurance, engineering, training, scheduling, and safety.

A core task force consists of 5-8 people, augmented as needed. For example, it would be wise temporarily to include workers whose jobs are being analyzed. Likewise, if the task force is considering new equipment purchases, it is a good idea to include a purchasing representative.

As the task force becomes proficient, it may spin-off new task forces, e.g., one for workshop activities or one for flight-line tasks. Current task force members can be assigned to spin-off groups and new members recruited to fill any vacancies. Typical task force composition is shown in **Table 2-4**.

Table 2-4. Typical Human Factors Task Force composition
Team Leader (1)
Human Factors Professional (1)
Workers (2 x AMTs or Inspectors)
Technical Specialists (2): Engineer Safety Professional Quality Control Professional

Task Force Organization

Early in its existence, the task force needs to determine how it will operate. A number of fundamental questions must be resolved to reduce members' uncertainty about how things will work: How many hours per week will the task force meet? Is attendance compulsory? **Table 2-5** provides a list of the most basic organizational issues.

Table 2-5. Basic task force organizational issues
Structure · Teams/Subteams · Committees
Leadership · Duties · Qualifications · Duration · Objectives
Meeting/Working Procedures · Attendance · Discussion · Voting · Meeting Locations
Reporting/Documentation
Membership Criteria

These organizational issues are often considered boring details, but determining organizational procedures need not be time-consuming. Early decisions on these issues prevent later procedural arguments.

Step 3-Train Task Force

Once the task force is formed and organized, its members must be provided with an appropriate level of knowledge about human factors principles and issues.

Professional Training

At least initially, it is more efficient and effective to have a person with a background in human factors assist with training. This person may be a member of the airline staff, but he or she should have formal human factors training and practical experience. Such experience and training is indicated by the person holding professional certification (Board of Certification in Professional Ergonomics, BCPE) and membership in the Human Factors and Ergonomics Society (HFES).

The professional may be teamed with the task force champion to ensure local buy-in and accurate technical coverage. After initial training, the professional's role becomes one of monitoring, advising, and consulting, decreasing to minimal involvement as the program matures and becomes self-sustaining.

Training Materials

The training programs should include material and exercises that build human factors expertise upon the foundation of task force members' existing job knowledge. An obvious source for course material is this *Guide*. **ICAO** circulars and reference material listed at the end of this chapter can be used to augment the *Guide*.

A powerful tool for bridging the gap between human factors concepts and existing job knowledge is to illustrate connections between the two. A good way to do this is for trainers to produce 20-50 slides of operations and equipment illustrating important points. These slides should show situations that exist in the local maintenance facility. That is, the scenes depicted in the slides should be familiar to the task force members.

Examples of possible subjects for training slides include lighting, **NDI** equipment interfaces, awkward work postures, and various types of support equipment. As far as possible, the slides should show both good and poor examples so task force members see familiar items and situations in a new light. Obviously some effects like noise and toxic fumes do not lend themselves to the visual medium of slides.

Table 2-6. Sample training syllabus for a Human Factors Task Force (1.5 days)

Topic	Hours
The Human Factors Model: **TOME** and **SHEL**	1
Why Human Factors: Good and poor examples from our hangar	1
The Human Body: Sizes, design of equipment and workplaces	1
Human Information Processing: Design of displays and information	1
Humans in Organizations: Socio-technical systems, design of work	1
Design of the Environment: Thermal / visual / auditory	1
Task Analysis Techniques	2
Human Factors Auditing	2
The Task Force Process: Seven steps	2

Table 2-6 is a syllabus for the task force training course. A lot of material can be selected and reproduced from chapters in this *Guide*. The course should begin with an overview of human factors concepts to give trainees an overall framework for subsequent topics. A major part of the course should be exercises that demonstrate each point. For example, it is easy to demonstrate working in visual glare or the effect of awkward postures on simple tasks.

As training progresses, incorporate case studies from the literature showing how effectiveness can be increased with, for example, better workcard design or Maintenance Resource Management (MRM) training. The **FAA**/**AAM** reports and conference proceedings are a good source for case studies.

Finally, trainees can analyze jobs with the Human Factors Audit Program to give them practice identifying worker/system mismatches. This is a good transition from training to the workplace; using the audit program can be the task force's first field activity after training.

Step 4-Analyze Selected Jobs

The fundamental requirement for implementing a human factors program is identifying potential human factors issues in the existing workplace. During this step in the implementation process, the task force selects and analyzes appropriate maintenance and inspection jobs. As noted in the **METHODS** section, steps **4**, **5**, and **6** constitute a design "cycle" and a human factors professional should support the first few cycles.

Choosing Jobs for Analysis

Although most jobs can benefit from human factors analysis, the choice of the first few jobs to be analyzed is important for a successful, long-term human factors program. A *job* can be either an **AMT**'s regular job if it is substantially similar each day, e.g., shop jobs, or a task defined by a workcard if the job changes daily.

With the program's onset, everyone from management to **AMT**s will be observing to determine if human factors "works." A successful beginning can be crucial for long-term enthusiasm for a program. The task force should initially select a job that can be successfully modified. As a minimum, the first job should be one that is possible to change. A problematic job with possibly inexpensive solutions can illustrate several salient points:

- Human factors fixes are not necessarily expensive
- Human factors analyses can be performed in-house
- Human factors work can be implemented rapidly.

Finally, the jobs chosen should not have an obvious solution. There is no point to performing a human factors analysis when an obvious fix is available. After the initial evaluations are successfully completed, the task force can tackle more difficult operations with a trained team and an enthusiastic organizational support.

The choice of workers is particularly important for the evaluation. The time required for data-collection will dictate the number of workers needed for analysis. Many procedures are time-intensive, forcing selection of a limited number of workers. Selecting representative workers can be problematic, for large variability in workers' methods is the rule, not the exception.[20]

Ideally, the team should select an experienced worker who uses correct work methods and does not have any obvious bad habits. If the team chooses a novice or poorly-motivated worker, then observers might later say that workers' problems are their own fault and no human factors intervention was required. If the team can analyze more than one worker, it should select people who use the most common working methods. The same workers should be used in subsequent reanalysis; no two workers perform a task with exactly the same method or body posture.

An obvious final criterion is that the workers chosen must be willing volunteers. Coerced data are technically suspect and morally dubious. If multiple shifts are involved, it is best to involve each shift, partly to ensure a representative sample and partly to ensure the program does not belong essentially to the day shift.

Choosing Analysis Methods

A human factors analysis can range from using a superficial checklist that requires perhaps five minutes per job to a detailed investigation lasting several weeks. For the program presented here, we recommend a relatively simple method - the ergonomics audit. Audits are available for both inspection and maintenance tasks.[11] The audits use tasks on a single workcard as their unit of study, e.g., "inspect tail interior" or "replace brake on main landing gear."

An audit uses common human factors standards and guidelines to evaluate procedures, equipment, and the environment to identify potential worker/system mismatches. It evaluates each issue shown in **Table 2-7**, using either a printed form or a portable computer for data collection.

Table 2-7. Issues evaluated by audit program

Information Issues	· Documentation · Communication in shift change · Communication for buy-back and repair
Environmental Issues	· Visual · Thermal · Auditory
Equipment Issues	· Availability · Equipment design
Physical Activity Issues	· Accessibility · Posture · Safety

Once data are collected, a computer-based analysis program is used to compare the results against standards and guidelines, printing out a list of possible mismatches. This list forms the base of redesign activities.

Involve Job Incumbents

Throughout this chapter, we have implied that maximum workforce involvement is essential for a successful program. An obvious way to increase involvement is to recruit incumbents to join the task force when it studies their jobs. As Subject Matter Experts (SMEs), their voices are vital to further describe problems the audit finds and to help suggest design solutions.

Step 5-Design/Redesign Solutions

Design, or redesign, occurs after human factors mismatches have been identified and before design solutions are implemented. Human factors professionals have developed a number of design strategies, all of which have certain commonalties. What we present is adapted from a method that has been used in various manufacturing domains.[9]

Specify Design Requirements

Design requirements are positive statements of what needs to be accomplished in the workplace redesign.[11] Based upon information obtained through the previous steps, a written list of design requirements should be produced. The purpose of design requirements is to reduce the risk of errors or injury by reducing or eliminating human-system mismatches. The audit's products are not solutions, but they are design requirements. There may be several alternative approaches for satisfying each requirement. **Table 2-8** shows the format and level of detail for typical design requirements.

Table 2-8. Typical design requirements from audit and analysis of a workcard.
Design Requirements for Workcard Design
1. Improve paper/printing contrast: put ribbon-changing on PM schedule.
2. Ensure updated and accurate information.
3. Ensure graphics agree with workcard text.
4. Keep graphics attached to workcard until after buy back.
5. Lay out workcard with clear IF-THEN statements.
6. Use logical breaks between card pages.

Formally stating design requirements can help generate solutions and reduce the probability that potential solutions are overlooked.[21] Workplace redesign is more successful when the team includes members with many different skills. This step allows the entire team to see and discuss the problems and to contribute to redesign. The fact that the design requirements are explicitly written in a list, keeps the discussion on track - without being distracted by suggestions that do not address basic workplace problems.

Generate Alternative Solutions

For each design requirement, the implementation team should try to generate more than one solution. Typically, a team generates alternatives using a method that requires all members to participate.[22,23] When generating alternatives, the team should follow the human factors principles in this *Guide*. A professional human factors practitioner can be of great help for this activity.

Solutions should not be prematurely constrained by engineering or administrative rules. After alternatives are generated, they should be subjected to the company's normal engineering and administrative controls. Engineering techniques should provide a permanent design that induces safe, error-free operating practices. Administrative solutions can be readily applied to reduce the immediate risks of workplace error and injury.

Administrative solutions differ in their effectiveness. Changes in procedures, such as checklists or workcards, can provide effective permanent solutions. Administrative techniques requiring continuous reinforcement, such as training or wearing protective clothing, are not always effective stand-alone solutions. In conjunction with engineering controls, most administrative measures can be effective.

Combining administrative and engineering solutions reduces costs, since the redesigned workplace induces good practices. For example, if a workplace is designed so that a manual materials handling (MMH) job can be performed without having to bend over, an **AMT** will not need training in proper lifting procedures.

Select and Prioritize Alternatives

Several alternative solutions may be developed to address each design requirement.

Alternatives can vary in implementation time and cost, from simple, straightforward, and inexpensive to substantial, sophisticated, and costly. Since human factors projects, like all projects, have finite resources available, it is necessary to select alternatives that maximize the performance benefit for a given cost. We have developed a procedure to assist in the selection process using each alternative solution's effectiveness and cost.

To determine a solution's effectiveness, design requirements **for a particular workplace or task** can be rated or prioritized according to a quantitative measure. One way to derive such a measure is to perform detailed analysis of the original job's potential for errors and injury. The measure would be reduction of errors and injuries resulting from meeting each design requirement. This type of detailed analysis quickly becomes quite complex. A more modest approach is ranking each design requirement according to its "ergonomic priority."

The scale shown in **Figure 2-8** can be used for this purpose. Each of the three important components of ergonomic priority are rated on 11-point scales. These three scale values are then multiplied and the product is divided by 100 to given an ergonomic priority "score" between 0 and 10: 0 represents lowest priority; 10, highest priority.

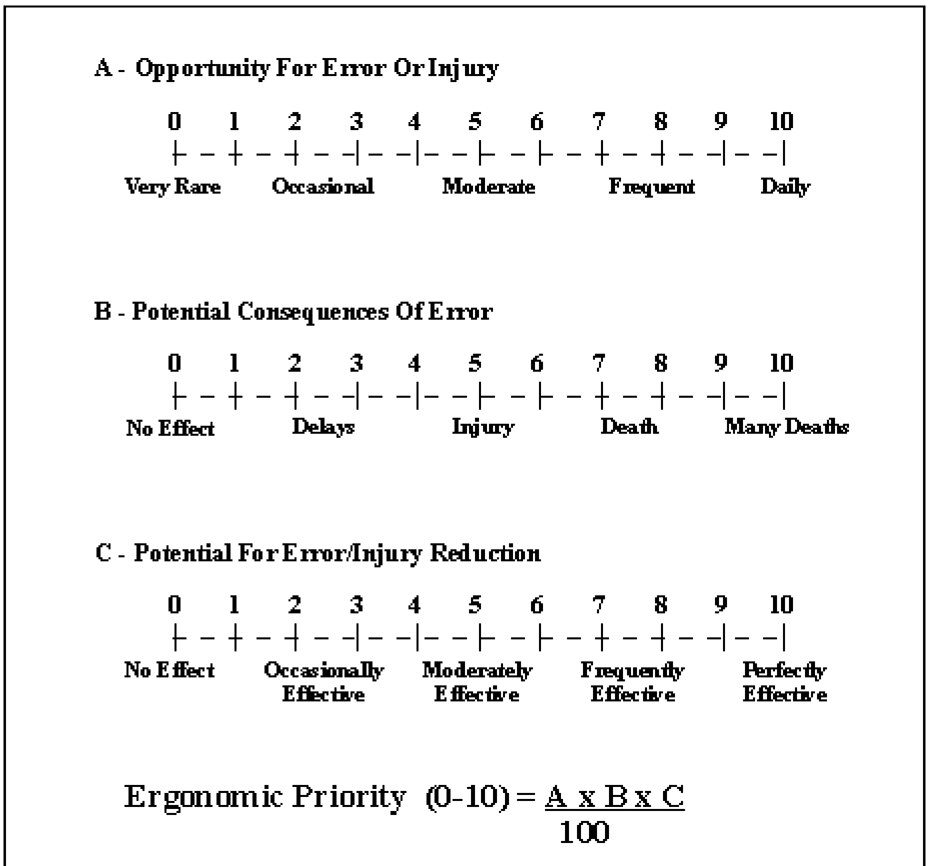


Figure 2-8. *Example of an "ergonomic priority" scale*

After the team develops an effectiveness measure, it needs cost data. Costs should be calculated on the same basis as effectiveness, i.e., **per workplace**, rather than for the entire hangar or department. Solutions involving major redesign affect many workplaces. An example of such a general solution is a new system of support stands. Other solutions, such as using task lights, involve a separate cost at each workplace.

All solutions should use the same time basis to incorporate both initial and ongoing costs and savings. Costs include labor and capital equipment. Savings include improved throughput, reduced medical and insurance costs, etc.

Combine effectiveness and cost data together in a single graph to present them to the human factors team and to higher-level decision makers in the organization. **Figure 2-9** shows such a graph on which alternative solutions for each design requirement can be overlaid. Some highly effective solutions cost little. Others cost more and are less effective.

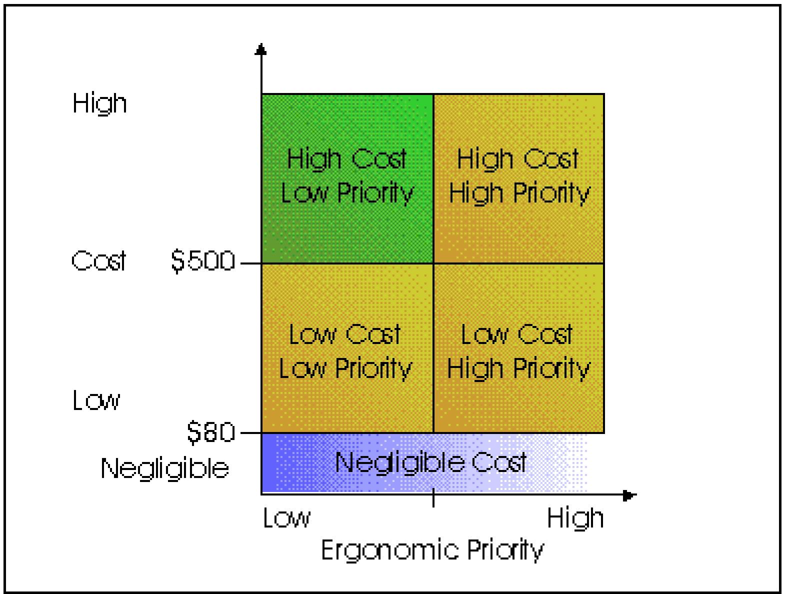


Figure 2-9. *Graph showing combined "importance" and cost criteria for various solutions*

The graph in **Figure 2-9** is divided into five regions as follows:

- First Region: Negligible Cost.

These solutions should be implemented regardless of their priority, provided they have no negative impacts. They are known colloquially as "no brainers."

- Second Region: Low Cost-High Priority.

These solutions should be implemented, provided they have no negative impacts. They are low-cost solutions to high-priority human factors problems.

- Third Region: High Cost-High Priority.

Depending on budget constraints, these solutions should be considered. Although these are high-cost solutions, they offer high error- and injury-reduction potential. Consider these solutions during long-term planning, e.g., during the purchase of new equipment.

- Fourth Region: Low Cost-Low Priority.

Depending on budget constraints, these solutions should be considered. Even though their potential for error- and injury-reduction is low, they cost very little to implement.

- Fifth Region: High Cost-Low Priority.

These solutions should probably be avoided. They are low in error- and injury-reduction potential and have high implementation costs. They may be implemented for reasons other than human factors, e.g., reduced direct labor costs or improved process control.

Lines separating regions on the graph are arbitrary. In **Figure 2-9**, a cost of less than $80 per workplace was considered a "no brainer," while $500 per workplace was the cut-off between low- and high-cost regions. Cut-off values should be adjusted to whatever are appropriate for each task force and organization.

Step 6- Implementation and Reevaluation

After design alternatives have been selected, they should be implemented in stages. First, a prototype incorporating the chosen solution(s) should be built and tested to demonstrate that the solution is effective. The solution should then be implemented in its production form. The task can be re-evaluated at that point to determine if it is effective in the workplace.

Prototype Testing

Solutions should be initially tested off-line with a simulated workplace. This need be only a set-up allowing quick adjustability. Wooden or cardboard models of required tools and machines, as well as adjustable benches and chairs, can produce an adequate mock-up.[21] *Adequate* means that a job incumbent can try different positions, adjustments, or lighting to get the best conditions.

For solutions involving physical workplace changes, anthropometric data (see **Chapter 6**) provide a starting point for initial dimensions. A reasonable design must accommodate a range of workers, not be designed for the average. Several workers, with a range of body dimensions, should be fitted to the prototype to determine final design dimensions. Since anthropometric data typically provide insufficient realism for working postures, the life-size adjustable mock-up is necessary to refine workplace design. Again, prototypes need not be elaborate; they are typically used for only a few hours.

The prototype test also provides an opportunity to discover design constraints and other factors that may have been overlooked, allowing the design to be fine-tuned. Mechanical fabricators' and maintenance people's input can provide crucial insight into practical design issues. Following the prototype test, place a working prototype on the hangar floor. Allow at least 1 to 2 weeks for workers to adjust to the prototype before attempting a reanalysis.

Reanalysis and Reevaluation

When workers have used and adjusted to the redesigned workplace, it should be reanalyzed. This procedure amounts to repeating the data collection and analysis procedures originally completed on the task/workplace combination. Replicate the "before" analysis as closely as possible, including derivation of quantitative performance measures. If possible, use the same analyst and the same worker. Such care is necessary to ensure that the analysis measures only human factors changes.

The reanalysis and re-evaluation allows the task force to quantitatively assess the impact human factors changes have on risks of injuries and errors, as well as the effectiveness of particular human factors solutions. Over time, the task force can develop a repertoire of successful interventions and apply them to other situations.

If there is no change in the audit results, human system mismatches identified in the original audit have not been eliminated. In this case, the design process must go through another cycle. However, this will be a rare outcome when this *Guide's* human factors principles are followed.

Step 7-Technology Transfer

After completing an initial set of human factors workplace changes, the task force is well-equipped to expand activities in two directions. First, it can continue its activities by adding new members. Second, it can provide a nucleus for other human factors teams. A human factors professional should supervise this process.

Extension of Task Force Activities

The original task force at each site has a number of roles by this point:

- Monitoring implementation activities for workplaces or systems that were changed. Were human factors benefits achieved? Did the solution remain implemented, or did it fade away because of lack of knowledge or commitment?
- Continuous improvement of previous solutions (noted earlier). This should be part of every organizational culture. Having the human factors task force follow the same procedure further establishes this as a mainstream organizational activity.
- Extension to other human factors aspects. If the first few jobs analyzed had the same type of mismatches, e.g., restricted space, the task force should choose jobs with different issues to avoid becoming a "one-solution" team.
- Rotation of task force members. Some initial task force members may wish to reduce their future commitment or may be involved in **spin-off teams**. New members must be chosen and trained as carefully as initial members. Continuing team members should provide training; it

is a good way to review and improve existing skills.

Extension to Spin-Off Groups

Members of the initial task force are good candidates to start new teams. If the first task force concentrated on hangar-floor maintenance jobs, new task forces could cover inspection, shop, or office jobs. Paperwork activities backing-up physical tasks on an aircraft are subject to human error and, thus, amenable to human factors analysis and intervention.

The task force should keep records of its activities and of solutions it considered. A piece of equipment considered for Job A and rejected may be ideal for Job B. A file drawer full of ideas for "ergonomic" equipment is a useful long-term resource, one which easily can be shared with other teams at the same site, with the corporate group, and with groups at different sites.

WHERE TO GET HELP

Human factors has been applied to aviation maintenance and inspection only relatively recently. The best source of assistance and recommendations is the **FAA**'s Office of Aviation Medicine (AAM), which has been managing programs in this area since 1990. Contact the AAM at the following address:

Ms. Jean Watson
Office of Aviation Medicine
Federal Aviation Administration
800 Independence Ave., SW
Washington, DC 20591
Phone: (202) 267-8393

Other groups with technical human factors knowledge include **FAA**'s Civil AeroMedical Institute (CAMI) in Oklahoma City, Oklahoma, and the Air Transport Association (ATA). Both organizations have active interests in this area. These organizations can be contacted at the following addresses:

Dr. David Schroeder
Director, Human Factors Laboratory
Civil AeroMedical Institute
PO Box 25082, AAM-510
Oklahoma City, OK 73125
Phone: (405) 954-4082
Fax: (405) 954-4852
Email: David_Schroeder@mmacmail.jccbi.gov
Web site: http://www.cami.jccbi.gov/aam-500

Air Transport Association
1301 Pennsylvania Ave., NW

Suite 1100
Washington, DC 20004
Phone: (202) 626-4000
Fax: (202) 626-4081 (Engineering)
E-mail: ata@air-transport.com
Web site: http://www.air-transport.org

FURTHER READING

The documents listed below contain information pertaining to implementing a human factors program. They may or may not have been referred to in the chapter.

Bailey, R.W. (1982). *Human performance engineering: A guide for system designers*. Englewood Cliffs, NJ: Prentice-Hall.

Kantowitz, B.H., and Sorkin, R.D. (1983). *Human factors: Understanding people-system relationships*. New York, NY: John Wiley & Sons.

Proctor, R.W., and Van Zandt, T. (1994). *Human factors in simple and complex systems*. Needham Heights, MA: Allyn and Bacon.

Salvendy, G. (Ed.) (1987). *Handbook of human factors*. New York, NY: John Wiley & Sons.

Sanders, M.S., and McCormick, E.J. (1987). *Human factors engineering and design, Sixth Edition*. New York, NY: McGraw-Hill.

Van Cott, H.P., and Kinkade, R.G. (Eds.) (1972) *Human engineering guide to equipment design, Revised Edition*. Washington, DC: US Government Printing Office.

EXAMPLE SCENARIOS

The scenarios presented below represent some typical program-related tasks that one can expect to encounter in the workplace. The purpose of including these scenarios in the *Guide* is to demonstrate how the authors foresee the document being used. For each scenario, we describe how issues raised in the scenario can be resolved. There is usually more than one way to approach these issues, so the responses below represent only one path that users of the *Guide* might take.

As a general rule, always start to look for information by using the Search function. There will be instances that you already know where required information is located. However, unless you frequently use specific sections of the Guide, you might miss information pertaining to the same issue located in more than one chapter. The Search will allow you to quickly search all chapters simultaneously.

Scenario 1 - Repair Shop Ergonomics

A number of incidents in the brake repair shop suggest ergonomic problems. Some mis-alignments have been found at final inspection, delays are rather common, and there have been four apparently-unrelated lost-time accidents. An ergonomics program may be needed, but you want to know whether it will be useful to recommend one.

Issues

1. How would you identify basic functions in the brake repair task and potential ergonomic problems with the task?
2. In what general form should functions be reported?
3. Give examples of changes, involving both changes to workers and changes to the system, that could result in human factors improvements.

Responses

1. In the **GUIDELINES** section of this chapter, we describe the analysis step that should take place as part of an ergonomics program. Two methods that can determine functions and potential ergonomic problems of any task, such as brake repair, are task analysis and an ergonomic audit. We don't provide enough detail in this scenario to analyze and audit the brake repair task. However, both methods include a general logical analysis of the task, perhaps from workcard information, followed by direct observation of **AMT**s performing brake repairs.

2. **Table 2-1** gives an idea of how to report task functions. Each function should have an obvious starting and ending point and should involve a logically grouped set of actions. An example of how brake repair functions might be listed is shown below:

- Clean brake assembly
- Disassemble
- For each component,
    - Clean
    - Inspect
    - Repair or replace
    - Test
- Assemble
- Inspect/Test.

3. Again, **Table 2-1** lists various changes to both workers and systems. In this scenario, typical changes might include the following:

Changes to workers: Team training such as Maintenance Resource Management (MRM) and cross-training to ensure that **AMT**s understand the whole system. (see **Chapter 16**)

Changes to the system: Adjust workbenches to the correct height and provide adjustable seating for the assembly station. Integrate the test/inspect function with the documentation system; for example, directly couple test machines to documentation in a computer.

Scenario 2 - Training the Task Force

An ergonomic task force set up for visual inspectors is charged with improving both inspection tasks' physical environment and visibility of indications to inspectors. You are responsible for setting up the training program for the task force.

Issues

1. What materials would you assemble for the training program?
2. How would you organize the material?
3. How long should the training last?

Responses

1. **Step 3** in the **GUIDELINES** section describes types of training materials for training the ergonomics task force. Such materials include this *Guide*, various **ICAO** documents, references at the end of this chapter, and photographic slides illustrating good and poor ergonomic practices from operational hangars. If possible, some (or all) of these slides should depict situations in your own operation.

2. **Table 2-6** shows typical training material arranged for an ergonomics task force course. This syllabus may be modified, depending on the visual inspection system's specific needs. More time should be spent on components of the human eye, on the visual environment, and on measures of individual differences in visual performance. Areas such as using power tools need little or no emphasis.

3. The syllabus in **Table 2-6** shows a course duration of 1.5 days. Actual program length depends on the task force's initial knowledge level and the level of detail in the material. Training rarely lasts less than one or more than three days.

Scenario 3 - Ergonomics Audit

You have set up an ergonomics task force in the **NDI** group with the very broad mission of improving human factors in NDI tasks. The task force consists of four NDI inspectors, the inspection manager, and an engineer. After analyzing four NDI tasks with the ergonomics audit, the engineer claims that there is no problem; inspectors should follow her instructions to the letter.

Issues

1. What will the ergonomics audit likely to find?
2. How would you use audit data and your knowledge of human factors to help the task force

move to generating and evaluating alternative solutions?

Responses

1. In our discussion of analysis methods in the **GUIDELINES** section (**Step 4**), we note that an ergonomics audit is designed to indicate potential mismatches between the system and its human workers. **Table 2-7** lists general issues and audit program addresses. In this scenario, the ergonomics audits will identify points in **NDI** tasks with mismatches between human capabilities and task demands. Data from previous human factors studies have shown that performance is best when demands and capabilities match. Any mismatch will incur a performance penalty usually seen in a higher error rate.

2. Instructions are only one line of defense against errors. Following instructions to the letter every time indeed ensures that no errors are committed, but the cost is high and enforcement is difficult. For example, if the calibration controls on an eddy current device go against population stereotypes, eliminating errors requires more effort than enforcing procedures. Redesigning the controls eliminates a class of error permanently (by design) and requires no enforcement.

It is possible to drive a car or fly an aircraft with reversed directional controls (steering or rudder). Enforcement of effective procedures would be an administrative nightmare, and errors would occur whenever a person attended to other parts of the driving or flying task. To make the point, ask task force members who are skilled and respected **NDI** inspectors to contribute war stories of previous errors they've made.

Scenario 4 - Selecting Alternatives in Maintenance Improvement

The maintenance task force generated the following three alternatives for improving access in the task of removing and replacing the elevator trim jack in a B-737:

1. Simple pads that allow the **AMT** to work on the unit without leaning directly on other equipment in the tail cone area
2. A short aluminum stand modified from an existing stand used in the nose landing gear wheel well to allow the **AMT** to reach the unit without undue forward stretching
3. A custom step/stand/body support/tool support fitting directly onto the tail cone's interior structure to allow easy access to both unit and tools. It disassembles for entry and egress.

Each team member has a favorite solution. Discussions on the issue degenerate into each person stating opinions of why "my" solution is best.

Issues

1. How do you help the team select the most appropriate alternative for your hangar?

Responses

1. It's clear from the description above that the team needs to move away from subjective feelings toward an objective evaluation of alternatives. Using the scales in **Figure 2-8**, the team can rate each alternative's ergonomic priority by reaching team consensus on each scale for each alternative or simply by averaging each team member's scale rating.

After the ergonomic priority is determined, the cost for each alternative can be computed. This should be a simple task having an objective outcome for each alternative. Once cost and priority for each alternative is known, use **Figure 2-9** to place alternatives in cost/priority space.

If there are no ergonomic priority differences among alternatives, choose the least expensive. If one alternative is clearly more ergonomically effective than the others, weigh its cost against its effectiveness. For alternatives scoring closely on both cost and effectiveness, other considerations, such as ease of storage, can figure into the decision.

Scenario 5 - Using Experts

Your company has a human factors initiative led by professionals from the head office. As part of the initiative, a human factors task force for your engine shop has been formed. Some strong-willed **AMT**s are eager to forge ahead changes to the workplace, the shiftwork system, and control panels for the magnetic particle inspection system.

The task force has seen a video on ergonomics and has a copy of this *Guide*. They feel that such a common sense idea as ergonomics should have been tried years ago. You talked to the human factors person from the head office, but the task force feels that no further training is necessary.

Issues

1. Are there dangers in proceeding without further human factors training?
2. How do you resolve the issue of retaining credibility both with the task force and your company's human factors professionals?

Responses

1. This situation is fairly common in human factors. Human factors appears obvious and reasonable, so it is easy to assume that human factors techniques and data are "common sense". Unfortunately, this attitude occurs only in retrospect. As in other areas of technology, things seem obvious when one knows the answer.

We don't specifically address this scenario's issues. However, the biggest danger in proceeding without further human factors training, or at least professional involvement, is that the task force will make errors well-known to human factors professionals. All human factors solutions are not obvious.

2. There is room for outside expertise and local job knowledge in an ergonomics program. In this case, the task force seems to have developed a useful understanding of ergonomics and has generated potentially useful interventions. It would be a pity to dampen their enthusiasm with the head office's heavy hand by forcing them into training that may not be specific to their engine shop. However, a deeper knowledge of human factors may prevent well-known errors from appearing in their proposed interventions. Additionally, a link to the corporate human factors program helps the program and gives the engine shop visibility.

One solution would be to have the corporate human factors professional act as a technical resource. The professional could attend meetings to provide technical input to solutions and to pave the way for engine shop personnel to present success stories at the corporate level.

Training by joint solution of problems is a viable alternative to an expert's "chalk and talk," especially when trainees are knowledgeable and enthusiastic.

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