Understanding the task

Identifying the potential for human failure in preventing an accident or exposure to substances hazardous to health requires having a thorough understanding of the task the person is carrying out. This document is not an exhaustive list of task analysis techniques (there are many books published on the subject), but to give examples of techniques commonly used for improving health and safety.

A thorough understanding of the task can contribute to:

- Accurate and workable procedures;
- Assuring the competence of employees;
- Determining appropriate staffing levels;
- Workload analysis;
- Design of workstations, plant and control systems;
- Person specifications for recruitment;
- Human error analyses as part of risk assessment; and
- Allocation of function i.e. identifying whether a task would be more accurately and efficiently run by a machine (e.g. monitoring system states) or a person (e.g. decision making).

There are different methods for achieving this understanding which are usually referred to as Task Analysis methods. All methods are based on observations of the task and physically demonstrating the task in a walk-through/talk-through on the plant or equipment where the task is carried out. Specific methodologies deal with how the information collected during the walk-through/talk-through are organised.

Walk-Through/Talk-Through

The walk-through/talk-through is a simple process which consists of an experienced person demonstrating how the task is carried out. Each step, no matter how minor (pressing a switch) or effortful (walking to the other end of the premises to collect a tool), is demonstrated. This includes communicating with other people, retrieving information from computers or display systems and making decisions on information retrieved.

In addition to the demonstrator, it may also be helpful to have an engineer and/or health and safety professional in the team. As the procedure is demonstrated, the team should identify what might go wrong if a particular step is not carried out or incorrectly carried out.

One member of the team should note down each step, the potential for human failure, and anything which the team believe might make that step more or less easy to perform (e.g. poor lighting, noise, difficult to reach locations).

- A description of the different types of human failure
- List of possible Performance Influencing Factors (PIFs)

To be effective, the walk-through/talk-through must be done in the location and on the plant or equipment where the task is carried out in reality. If specific personal protective equipment is required for the procedure, then locating and putting on the PPE should be demonstrated at the appropriate point, and the demonstration continued wearing the PPE. This helps to identify actions which might be made difficult by e.g. gauntlets, time-limited breathing apparatus etc. Likewise, if specific tools or equipment are required for the task, then they should be fetched at the appropriate stage in the procedure. This helps to identify problems with accessing the necessary equipment.

However, the equipment or process does not need to be running at the time, and it may be unsafe to conduct a walk-through/talk-through on activities where distraction or delayed action could contribute to an accident or exposure.

At the end of the walk-through/talk-through the team will have a step-by-step list of the actions carried out and decisions made in a particular activity, know which of those are safety critical, and have an understanding of the factors which might affect human performance in carrying them out.

For many activities this level of analysis will be sufficient to identify the potential for human failure to contribute to an accident. However, if you have identified through risk assessment that an activity is key to preventing a major accident, a fatal accident or a potentially fatal exposure then a more structured analysis will be appropriate if:

- The task is complex and carrying it out in the correct order of steps/sub-tasks is important; and / or
- The task is infrequently carried out;
- The task requires sound decision-making based on multiple sources of information; and / or
- The task requires effective communication between lots of people.

Hierarchical Task Analysis

Hierarchical Task Analysis (HTA) is a way of organising the data collected during the walk-through/talk-through in a highly systematic way. The key advantage of an HTA is that it allows consideration not just of each task step, but of the way in which task steps are related to each other, the order in which they are carried out, and what would happen if a group of related task steps were miscarried.

HTA, whilst not complex, does require some training to carry out. The usual process is to identify the goal of a procedure e.g. ‘clearing a blockage on the machine’. The task steps identified through the walk-through/talk-through are then grouped into operations necessary to achieve the goal e.g.

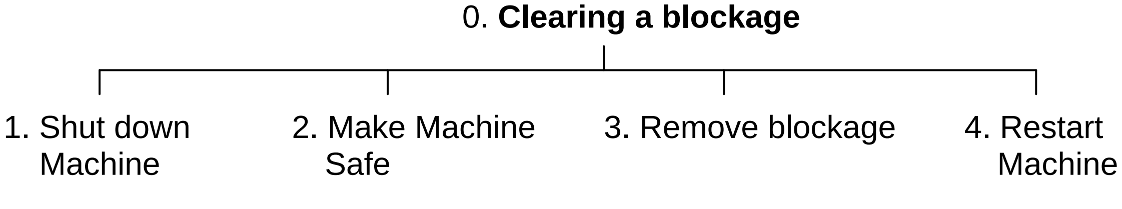


Figure 1: Example of a hierarchical task analysis (a)

Each of these operations (1-4) are broken down into sub-operations:

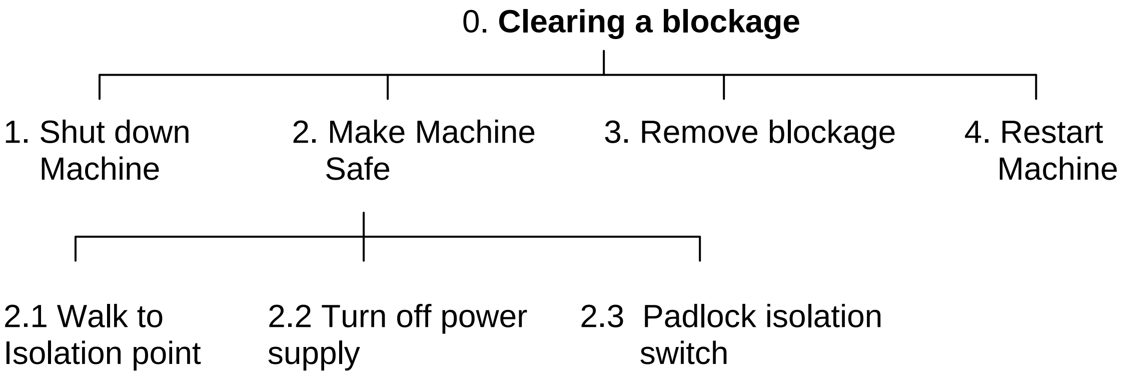


Figure 2: Example of a hierarchical task analysis (b)

The next step is to draw up ‘plans’ which specify the order in which the operations should be carried out. Plan 0, for example, would be “Do steps 1 to 4 in order”. Plans can be more complex and involve checks e.g. “Do steps 1 to 4, if blockage cleared continue, if blockage remains repeat steps 1 to 4 in order”. Plan 2 would be “Do steps 2.1 to 2.3 in order”.

Based on the walk-through/talk-through, the preconditions for achieving the goal are identified. This might include the availability of sufficient trained staff, the necessary tools, working at height equipment, raw materials and so on.

The HTA therefore contains four components:

- The goal
- Operations and sub-operations
- Plans
- Preconditions

Each of which can be analysed for potential failure – what if the operator has the wrong goal; what will the operator do if a precondition is not available; what if a plan is carried out in the wrong order, or not carried out – in addition to the operational failures that might occur in each task step as identified in the walk-through/talk-through.

Link Analysis

Like HTA, link analysis is a way organising the information gathered in the walk-through/talk-through. This methodology is used to examine the spatial relationships between the operations or task steps that the employee carries out. On a small scale, link analysis can be used to identify the controls and displays most frequently accessed by an operative in a task so that they can be grouped together in the most prominent and readily accessible part of the workstation. For this reason, link analysis is most often used in the design of new plant and equipment but it can also be a useful technique in understanding inefficient procedures (which are prone to non-compliance), and in improving the design of workstations and control interfaces.

Figure 3: Clearing a blockage link analysis

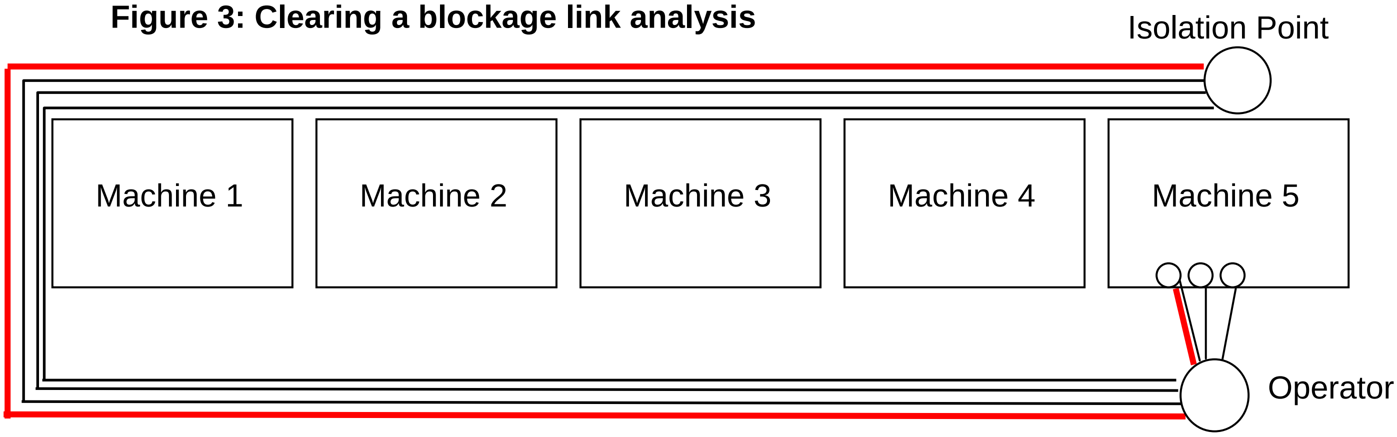
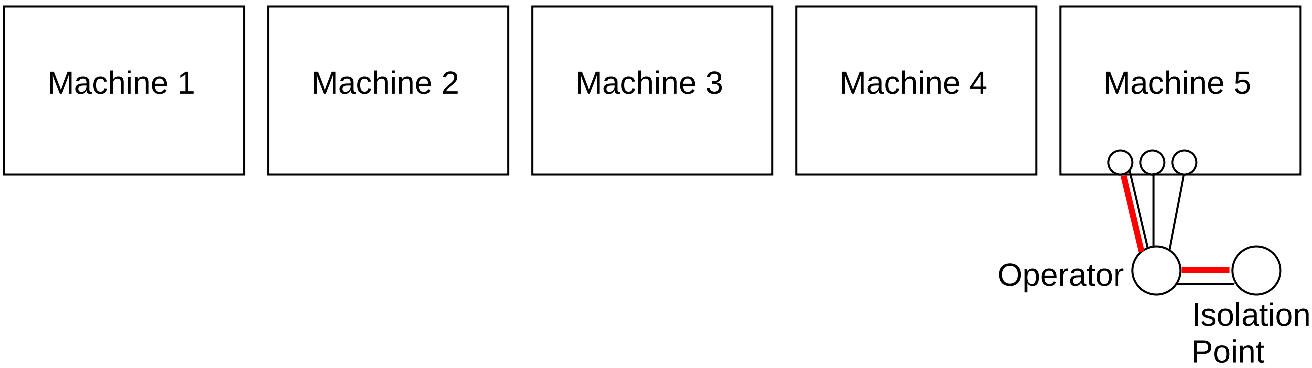


Figure 3 above shows a simple link analysis for clearing a blockage on machine 5. Red lines indicate the tasks which are safety critical. An additional line is added for each interaction with the control. In this procedure, the operator presses the stop button on the machine, isolates the machine, clears the blockage, de-isolates the machine, press the power on button on the control panel, then sets the machine away. The operator has to visit the isolation point twice – to isolate and then de-isolate the machine. The more frequently the operator has to interact with a control, and the more important the control, the nearer it should be to the operator.

Redesigning the controls increases the likelihood that the operator will follow the safe working procedure and isolate the machine before clearing a blockage.

Figure 4: Clearing a blockage link analysis after redesign



Time-line Analysis

There are many different ergonomics methods which consider the timing of tasks and operations in the workplace. Many of these are designed to increase the efficiency of the process, to identify staffing needs or to predict how much product an individual or team can process e.g. time and motion studies.

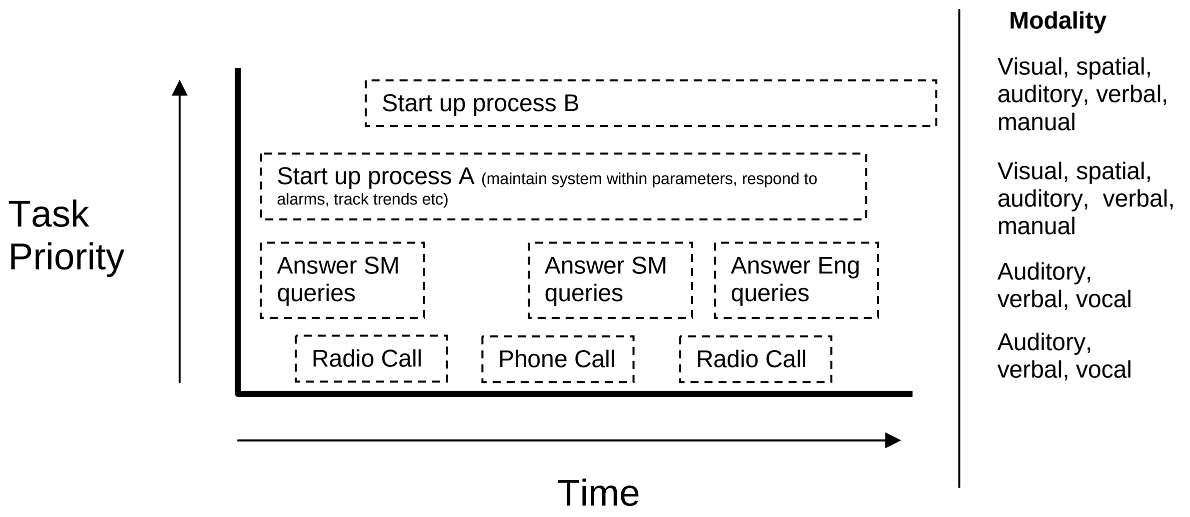
Time-line analysis is described here because it is an appropriate method for understanding the demands placed on an operator by their role. Full time line analysis is a complex method which requires a knowledge of human information processing, and companies should seek competent advice before applying it. However, simply mapping activities against a time line can be informative.

Time line analysis can be used proactively to identify tasks or combinations of tasks which place too much demand in an individual's ability to process information. A draw back to using any time study such as this one is that it can be hard to predict the demands placed on an operative by abnormal events such as plant upsets in the process industry. Time line analysis can also be used reactively (as in the example given in figure 5 below) to illuminate why an operative may have failed to complete a task successfully.

As with the other task analysis methods described here, time line analysis is based on task observations and walk / talk throughs. In addition, timings are taken of either individual task steps or tasks (as in the example below) as appropriate. These are then mapped against a time line to see which activities take place simultaneously.

In order to understand the demands simultaneous tasks place on a person, human factors specialists refer to the sensory and output modalities the task takes place in. For example, when we are speaking to someone, the sensory modality is auditory and the output modality is verbal. When we are driving a car, the sensory modality is visuo-spatial and the output modality is manual. Human beings have a limited information processing resource. When demands are light, people are able to speak to someone and drive a car at the same time. However, should demands increase (a distressing conversation, a complex driving environment), the demands placed on the information processing resource mean that performance will deteriorate on one task or the other.

Figure 5: Time line analysis



The example given in figure 5 above is a retrospective time-line analysis of an incident in which a company lost containment of a highly toxic material. The operative was starting up two processes (A first, followed by B) and at the same time answering queries made to him by his Shift Manager (SM) and a process engineer (Eng) made in person in the control room. Also at that time, an outside operator was radioing into the control room for instructions and to provide information on a problem he had identified outside. The operator failed to correctly interpret the alarms (auditory / verbal) occurring on process A leading to a plant upset. Understanding the different modalities makes it clear why the operator made this error since there was too much demand on the auditory / verbal modalities, but simply looking at the tasks mapped against the time line gives a clear indication that the workload for this operator role was too high.

References

Kirwan, B. (1994). *A Guide to Practical Human Reliability Assessment*. CRC Press: London.

Stanton, N. A., Salmon, P. M., Walker, G. H., Baber, C. and Jenkins, D. P. (2005) *Human Factors Methods: A practical guide for engineering and design.* Ashgate: Padstow.

Wilson, J. R. and Corlett, E. N. (eds) (1995). *Evaluation of Human Work: A practical ergonomics methodology. Second edition.* Taylor and Francis Group: Padstow.