Summary of task analysis techniques

This section provides a quick reference guide for all the techniques referred to in Chapter 1, listed in alphabetical order. A number of these techniques 25 are described in more detail in Part II of this *Guide*, and in the annotated listing that follows these are cross-referenced to their detailed description in Part II. For the other techniques, a brief summary is given, together with a reference for further information, listed in full in the bibliography. For each technique, the earliest appropriate system life cycle stage is also specified, along with the principal relevant human factors issues which the technique can be used to address.

1. **Activity sampling** (pp. 41)
Real-time human actions are observed and recorded regularly at a selected sampling interval. Sampling must be at a frequency which is at least twice the frequency of the behaviour which is of most interest or, for routine repetitive tasks, sampling should take place at random intervals. A limiting factor is whether the data collector can keep up with the worker.

Earliest life cycle stage:	Commissioning
Human factors issues:	Performance assurance

2. **Barrier analysis** (pp. 169)
This approach aims to identify hazards that could lead to accidents. For each of these, any barriers that could prevent the accident should be recorded along with their method of functioning (barriers can be both physical and non-physical) and modes of failure (including human error causes). This is followed by a check on how the barrier failure could be recovered.

Earliest life cycle stage:	Preliminary design
Human factors issues:	Task and interface design
	Performance assurance

3. **Charting and network techniques** (pp. 81)
There are a range of charting and network techniques available for representing and analysing tasks, eight of which are reviewed in Chapter 3 (pp. 82 – 93). Their aim is to represent the task concisely in a graphical form, often highlighting particular aspects of the task. Usually they are used to represent system and human task interactions in one graphical medium.

Earliest life cycle stage:	Flow-sheeting
Human factors issues:	All

4. **Coding consistency** (see pp. 226)
A reporting form is produced which must consider the acceptability of coding from both the coding method and the coding function points of view (one code given to one meaning, one meaning given to one code). This should enable a check for coding inconsistency or coding incompatibility and subsequent rectification.

Earliest life cycle stage:	Detailed design
Human factors issues:	Task and interface design
	Skills and knowledge acquisition
	Performance assurance

5. **Cognitive task analysis** (Diaper, 1989)
Cognitive task analysis covers a range of approaches used for looking at mental (hence cognitive) internal events or knowledge structures. One particular example of a technique in this domain is task analysis for knowledge descriptions (TAKD). TAKD uses a knowledge representation grammar to represent the knowledge required to carry out a task. This information is further represented in a task descriptive hierarchy, and so can be seen as a parallel technique to HTA. TAKD and other cognitive task analysis techniques have been used primarily in the field of human–computer interaction (e.g. for identifying training needs, evaluating computer dialogue systems, or for knowledge elicitation in expert systems development).

Earliest life cycle stage:	Detailed design
Human factors issues:	Task and interface design
	Skills and knowledge acquisition

6. **Computer modelling and simulation** (pp. 147 and Chapter 11)
The use of computer programs to represent the workers' activities or environment. A number of simulation runs can be made aggregating activity sequences, and these will assist estimation of cycle times, operator strategies and error likelihoods. Alternatively, the workspace layout can be graphically represented on computer, allowing analysis of visual access, layout adequacy, etc.

Earliest life cycle stage:	Flow sheeting
Human factors issues:	Staffing and Job Organization
	Performance assurance
	Task and interface design

7. **Confusion matrices** (Potash *et al.*, 1981)
This is a tabular plot of a set of stimuli (e.g. displays) against a set of related responses. The frequency of actual task responses are recorded in the grid squares, with the diagonal showing the frequency of correct responses. It is then possible to look at the grid and identify which responses may be made mistakenly for a given stimulus. Confusion matrices have been used in human reliability assessments to look at potential misdiagnosis during abnormal events.

Earliest life cycle stage:	Detailed design
Human factors issues:	Performance assurance

8. **Critical incident technique** (pp. 47)
Collection and analysis of information about incidents. Each incident is categorized to identify factors that are associated with or responsible for an incident occurrence. The intent is to identify when, where and why critical incidents occur.

Earliest life cycle stage:	Commissioning
Human factors issues:	Performance assurance

9. **Decision–action diagrams** (see pp. 87)
These diagrams are information flow charts constructed in the same way as those used for computer program development. Each section is initiated by an information input, which is followed by a decision block from which there may be alternative response routes which can be developed further.

Earliest life cycle stage:	Flow sheeting
Human factors issues:	Skills and knowledge acquisition

10. **Decomposition Methods** (pp. 95 and Chapters 9 and 16)
This produces an expansion of a task description into a series of statements about the task. Initially a set of short descriptions of all task elements is produced, more information is then elicited for each using a pre-determined set of sub-headings. These sub-headings are chosen by the analyst to obtain the necessary information to address the particular issue under consideration (e.g. cues initiating action, controls, decisions, errors, responses, feedback, etc.).

Earliest life cycle stage:	Detailed design
Human factors issues:	Task and interface design
	Skills and knowledge acquisition
	Performance assurance

11. **Ergonomics checklists** (pp. 217)
There are a range of checklists available for directly assessing tasks and their interfaces (e.g. for assessing the workplace, its environmental aspects, or VDU systems, etc.). Some checklists (e.g. Fitts list) can be used for broad allocation of function.

Earliest life cycle stage: Concept
Human factors issues: All

12. **Event trees** (pp. 178 and Chapters 14 and 16)
An event tree is a graphical logic method for identifying the various possible outcomes of a given event, known as the initiating event. The course of events from the occurrence of the initiating event until its final consequences is determined by the operation or non-operation of various systems (human and hardware). An event tree is typically used to model the reliability of safety systems, including operator intervention, designed to prevent an initiating event turning into a catastrophic accident.

Earliest life cycle stage: Preliminary design
Human factors issues: Performance assurance

13. **Failure modes and effects analysis** (pp. 184 and Chapter 9)
This technique is used in human reliability analysis. It allows the analyst to consider what errors might occur during a task and their likely consequences for the system. It can also be used to enhance error recovery and to identify error reduction measures.

Earliest life cycle stage: Preliminary design
Human factors issues: Performance assurance

14. **Fault trees** (pp. 188 and Chapters 14 and 16)
Fault trees show failures that would have to occur in order for a 'top event' (accident) to occur. These are constructed as a series of logic gates descending through subsidiary events resulting from basic events at the bottom of the tree. These 'basic events' may be human errors, or hardware/software failures, or environmental events. Sensitivity analysis to determine the most important events (i.e. which events contribute most to the likelihood of system failure) is possible once the basic event likelihoods have been quantified.

Earliest life cycle stage: Flow sheeting
Human factors issues: Performance assurance

15. **Function analysis system technique (FAST)** (see pp. 112 and Chapter 7)
FAST was originally developed to understand how systems really work and how they may be modified to save costs. As the functional analysis is undertaken, two questions must be asked: '*How*' does a sub-ordinate function achieve a super-ordinate one? and '*why*' is a super-ordinate function dependent upon a sub-ordinate function? Super-ordinate and sub-ordinate functions can be connected by **AND** and **OR** gates in order to facilitate a logical check of the overall function requirements.

Earliest life cycle stage:	Concept
Human factors issues:	Allocation of function
	Staffing and job organization
	Skills and knowledge acquisition
	Performance assurance

16. **Goals, operators, methods and selection rules model (GOMS)** (Card *et al.* 1983)
Initially the tasks are described as a set of goals and sub-goals similar to a HTA. At the required level this breakdown is stopped and each sub-goal is described in terms of the operations required to achieve it. An operation (or operator) is an elementary perceptual, motor or cognitive act, whose execution is necessary to change any agent of the user's mental state or to affect the task environment. Methods describe the procedures used to achieve a goal which have a specified chance of success. Selection rules are rules used to predict which of several possible methods will be selected by the user, based on task environment characteristics. GOMS allow hierarchical representations of goals which is useful, and GOMS can provide a complete dynamic description of behaviour. If times can be estimated for individual systems, then the GOMS model predicts the time necessary to complete tasks, although it will not consider errors. GOMS has mainly been used for human–computer interaction.

Earliest life cycle stage:	Detailed design
Human factors issues:	Skills and knowledge acquisition
	Staffing and job organization
	Performance assurance

17. **Hazard and operability study (HAZOP)** (pp. 194)
Based on pipework and instrumentation diagrams (P&IDs) or operating instructions, a set of guide words is applied to each stage of a process to identify potential hazards, possible consequences and preventive mechanisms. Success of a HAZOP is dependent upon co-operation of an interdisciplinary group, sometimes including ergonomics (human factors) expertise.

Earliest life cycle stage:	Flow sheeting
Human factors issues:	Task and interface design
	Performance assurance

18. **Hierarchical task analysis (HTA)** (pp. 104 and all of Part III apart from Chapters 7 and 11)
The best known task analysis technique, used to represent the relationship between tasks and subtasks. It records system requirements and how these can be achieved, including the order in which tasks and subtasks must take place. If recorded pictorially it resembles a tree with branches and sub-branches as required.

Earliest life cycle stage: All
Human factors issues: All

19. **Influence diagrams** (pp. 201)
Target events (e.g. system failure) are defined prior to using the technique, and an assessor then produces a directed graph representing the influences (e.g. procedure adequacy etc.) that determine the outcome of each event (i.e. success or failure), together with any dependencies between them. The effect of each influence is then evaluated, with the resulting values used to weight human error probability estimates.

Earliest life cycle stage: Preliminary design
Human factors issues: Performance assurance

20. **Information and controls analysis** (see pp. 224)
First the task description is tabulated, then each subtask is examined in order to identify any associated decision requirements plus the information needed to ensure that the decision is effective. If an active response is required, the type of control should be noted with a description of feedback requirements.

Earliest life cycle stage: Preliminary design
Human factors issues: Task and interface design
Skills and knowledge acquisition

21. **Interface surveys** (pp. 223)
These are a group of methods which can be used to identify specific ergonomics problems or deficiencies in the interfaces which are provided (e.g. the labelling of controls and displays, or the environmental conditions which are provided).

Earliest life cycle stage: Detailed design
Human factors issues: Task and interface design

22. **Link analysis** (pp. 118)
An annotated diagram showing visual/physical movement between system components, including frequency of movement and component importance. It is used to analyse the relationships between system components to optimize their arrangement by minimizing movement times/distances and by placing important items in prime positions.

Earliest life cycle stage:	Preliminary design
Human factors issues:	Staffing and job organization
	Task and interface design
	Performance assurance

23. **Management oversight risk tree (MORT)** (pp. 208)
A technique used to investigate the adequacy of safety management structures either to ensure that these exist or, if an incident has occurred, to determine which safety management functions have failed. The MORT system, in its accident investigation role, firstly defines what barriers have failed to allow the accident to occur, and then searches for the root causes of these failures as failed safety management functions. The MORT system uses a diagrammatic (qualitative) fault tree and a highly structured accident investigation audit system to identify the causes of the accident.

Earliest life cycle stage:	Commissioning
Human factors issues:	Performance assurance

24. **Observation** (pp. 53)
Observation is the most fundamental data collection technique and can range from direct viewing to video recording, or to participative observation, in which the analyst is involved in carrying out the task. These methods vary in their effectiveness and their intrusiveness on the job incumbents.

Earliest life cycle stage:	Detailed design
Human factors issues:	All

25. **Operational sequence diagrams** (pp. 125)
A diagram that makes use of standard symbols, often in the form of a flow chart linking operations in the order in which they are normally carried out, supported by a text description. It is used to illustrate relations between personnel, equipment and time.

Earliest life cycle stage:	Preliminary design
Human factors issues:	Staffing and Job Organization
	Skills and knowledge acquisition
	Performance assurance

26. **Operator action event tree** (see pp. 180 and Chapter 16)
A representation of success and failure routes through a sequence of 'actions', each of which is an information input, a processing activity or an output element. Any level of task detail can be used since it was originally designed as a holistic approach. Each stage in the route can be given a failure probability resulting in an overall probability of failure/success for the complete event sequence.

Earliest life cycle stage:	Preliminary design
Human factors issues:	Performance assurance

27. **Operator modification survey** (see pp. 228)
An assessor enters the workplace and looks for any temporary modifications made by the workers. These are recorded under three headings; memory aids, perceptual cues and instrument grouping. From this it is possible to establish user difficulties even with well-established systems.

Earliest life cycle stage:	Commissioning
Human factors issues:	Task and interface design
	Performance assurance

28. **Petri-nets** (see pp. 91)
These are state transition networks which distinguish between states (conditions) and transitions (events). As a condition is achieved it is marked, but a transition is impossible until all previous states are marked. Progress is shown as dependent upon the system state. This forces the analyst to record the result of all activities.

Earliest life cycle stage:	Operation and maintenance
Human factors issues:	Performance assurance

29. **Position analysis questionnaire (PAQ)** and **Job components inventory** (see pp. 62)
These are specific questionnaires which are used for gathering job information. They are usually used to identify general job characteristics and have been used primarily for personnel purposes. They seek to identify which job elements are present or absent in an occupation. The Job Components Inventory gathers information on a total of 194 job elements grouped into six divisions.

Earliest life cycle stage:	Operation and maintenance
Human factors issues:	Person specification
	Skills and knowledge acquisition

30. **Process/system checklists**
Used to check that a system complies with pre-determined standards. These are easy to use, and can be applied at any stage in the system life cycle. They provide a systematic baseline which can also be used to assess success. A checklist may be designed as a form for approval prior to a project moving to its next phase. The success of a checklist is dependent upon the expertise of the author and its interpretation by the assessor.

Earliest life cycle stage:	Concept
Human factors issues:	All

31. **Questionnaires** (pp. 58)
A formalized and standardized set of questions, which can include open-ended questions, produced to elicit a wide range of responses. In general they are used to collect systematically and in an unbiased way a variety of individuals' views of a particular task or system.

Earliest life cycle stage:	Concept
Human factors issues:	All

32. **Signal flow graph analysis** (see pp. 92)
This technique identifies the important variables within a system and enables their relationships to be detailed. An output variable from the system is selected and all the variables that can influence this are identified. The variables that affect these are then identified, until all the output and input variables have been found and linked together. Variables are shown as nodes connected by lines to show their causal dependencies.

Earliest life cycle stage:	Flow sheeting
Human factors issues:	Task and interface design
	Skills and knowledge acquisition
	Performance assurance

33. **Simulators/mock-ups** (pp. 150)
Development and use of equipment or information (this may be through high-or-low fidelity simulators) that is representative of what will be used during the task. Task activity while using this is then observed and recorded.

Earliest life cycle stage:	Preliminary design
Human factors issues:	Task and interface design
	Skills and knowledge acquisition
	Performance assurance

34. **Structured interviews** (pp. 66 and Chapter 8)
A systematic collection of verbal information. An interview consists of a basic question and answer session with prepared questions asked by the interviewer with the replies either written down or taped. Extra information can still be added or a relevant issue pursued.

Earliest life cycle stage:	All
Human factors issues:	All

35. **Table-top analysis** (pp. 155)
A group of experts meet to discuss a problem perspective of the task, using task scenarios to explore the problem and derive a solution. The technique seeks to aggregate expert opinion in a problem-solving mode.

Earliest life cycle stage:	Concept
Human factors issues:	Skills and knowledge acquisition
	Performance assurance

36. **Timeline analysis** (pp. 135)
Timeline analysis maps operators tasks along the time dimension, taking account of task frequency and duration, and interactions with other tasks and other personnel. Timeline analysis is useful for estimating staffing requirements via workload considerations, and can also be used in human reliability analysis to consider whether an operator or operating team are likely to complete a task within a particular time.

Earliest life cycle stage:	Detailed design
Human factors issues:	Staffing and organization
	Performance assurance

37. **Verbal protocols** (pp. 71)
Verbal protocols are the recorded verbalizations of operators as they carry out their tasks. It is important that these verbalizations should not interfere in any way with task performance and that the operators should freely report on what they are doing without any direction from the analyst. These protocols are particularly useful for gaining information about the unobservable cognitive reasons for operators actions in certain situations, which cannot be directly observed. Verbal protocols are limited by the ability of subjects to freely and honestly state why they are carrying out particular actions, without first making a conscious effort to explain these actions.

Earliest life cycle stage:	Commissioning
Human factors issues:	Skills and knowledge acquisition
	Task and interface design
	Person specification

38. **Walk-through/Talk-through analyses** (pp. 160)
Workers who know the system demonstrate associated tasks, either on the plant or a representation of it. As a full technique they physically move around the workspace while describing and explaining the required actions and work methods (doing the actions prompts the worker). The movements (only usually for walk-throughs) and comments (both techniques) must be recorded and analysed.

Earliest life cycle stage:	Detailed design
Human factors issues:	Skills and knowledge acquisition
	Task and interface design
	Performance assurance

39. **Withheld information** (Duncan and Reiersen, 1988)
Many decision-making tasks require the operator to look at several information sources, presented simultaneously on a variety of display media. This technique is used to identify how operators select and use the information. A simulated task environment is constructed and information is withheld from the operator until it is specifically requested. A set of events are presented one at a time to the operator who must identify and deal with each of them. This is achieved by asking for items of information, one at a time. As each item is requested it is recorded by the analyst within a previously constructed matrix.

Earliest life cycle stage:	Detailed design
Human factors issues:	Person specification
	Task and interface design
	Skills and knowledge acquisition

40. **Work safety analysis** (see pp. 172)
This is a systematic analysis of a chosen work situation for all possible occupational accidents plus the measures that may be adopted to reduce or eliminate their likelihood. The work for analysis is divided into major steps and placed within a tabular format, and each work step is then examined using expert judgement, experience and accident reports to determine the following: possible accidents, causative factors, relative likelihood, seriousness of consequences, a risk index, and corrective measures. By assessing the initial and reduced risk figures given by implementing each suggested corrective measure, the cost effectiveness is derived and the most suitable corrective measures recommended.

Earliest life cycle stage:	Operation and maintenance
Human factors issues:	Skills and knowledge acquisition
	Performance assurance

41. **Work study techniques** (Barnes, 1968)
A family of techniques devised to rigorously itemize the different steps required to perform a task, to establish if the best method is being used. A recorder must observe the task and make a note of basic physical work units in the order of completion, while using a standard notation system. This can be improved by sensory motor process charts which focus on the sensory processes and decision-making. The charts are used to determine if a simpler (or more ergonomic) method can be used to action the task. This would also require reference to ergonomics data bases on anthropometry, biomechanics, repetitive strain injuries etc., if applied to manual handling or repetitive tasks.

Earliest life cycle stage:	Operation and maintenance
Human factors issues:	Skills and knowledge acquisition
	Performance assurance
	Task and interface design
	Allocation of function

References

Barnes, R.M. (1969) *Motion and Time Study*. New York: John Wiley.

Diaper, D. (1989) *Task Analysis for Human Computer Interaction*. Chichester: Ellis Horwood.

Duncan, K.D. and Reiersen, C.S. (1988) Long Term Retention of Fault Diagnosis Skills. In *Training, Human Decision Making and Control*, Patrick, J. and Duncan, K.D. (eds.). pp. 93-118. Oxford: North Holland Publishing.