CHAPTER 4

Systems approaches to training

4.1 WHAT IS A SYSTEMS APPROACH?

There are two important aspects of a systems approach. Firstly, any functioning entity can be viewed as a system and defined in terms of its objectives or what it is attempting to achieve. A car, a university, or indeed training within an organisation can be viewed as a system with its own specific goals or objectives. Secondly, a system can be broken down into its subsystems and the interrelationships between them. These subsystems perform different functions which enable the system to achieve its objectives. For example, a car can be represented as a system whose overall objective is to achieve motion in a controllable fashion. This system can be divided into various subsystems, each of which performs a particular function, such as the braking subsystem and the fuel subsystem. All of these subsystems inter-relate in a specifiable manner to achieve the controllable movement of the car. Any change in the interrelationships between subsystems or the functions they perform can affect the operation of the system.

From this it follows that systems should be viewed hierarchically. A car is part of a road transport system which is in turn part of a transport system. Conversely, the braking subsystem of a car can be partitioned into its own subsystems which in turn can be further subdivided. Therefore use of the term "system" or "subsystem" is relative and depends upon one's perspective. It is not contradictory to speak of *X* as a system which can be divided into subsystems whilst also describing *X* as a subsystem of something else. The attraction of the systems approach is not in its rigour but in its generality and the perspective which it brings. It enables us to ask searching questions concerning what a system is trying to achieve and what functions have to be performed for this to happen. It also emphasises that it is important to analyse the interrelationships between subsystems within a system. Subsystems may transfer information, mass, energy or control between each other and this transfer can take place in one or both directions. Transfer of information between two subsystems can enable them to be self-regulating. For example, an organisation is a system composed of various subsystems, including one concerned with training and another with recruitment/selection. If the training subsystem spends too much time or money in producing trained personnel, then this information may effect a change in the recruitment/selection subsystem.

A systems approach provides insights into the domain of training in two ways:

1. Training can be viewed as a system which interacts with other systems such as personnel selection and ergonomics. Whilst this book is primarily concerned with training it is important to remember that these other systems may also hold the solution to a particular occupational or educational problem. The interaction of training with other such systems will be considered briefly in Section 4.2.
2. The development of training can itself be viewed as a system and can be analysed into its subsystems and how they interact with each other. This enables us to identify different functions involved in developing training programmes. This has given rise to what are termed Instructional Systems Development (ISD) models, four of which are discussed in Section 4.3. The advantages and disadvantages of such an approach are considered in Section 4.4. Such models provide a useful introduction to the various activities involved in developing training materials. The psychological contributions to these different training functions are elaborated in later chapters of this book.

4.2 TRAINING AND RELATED SYSTEMS

The training system interacts with the systems concerned with ergonomics and personnel selection. All three provide potential solutions to a performance problem and therefore need to be considered. An ergonomic approach attempts to design or redesign the person's job or tasks such that their psychological requirements are reduced, possibly with an improved human–machine interface. Sometimes this is not feasible possibly due to investment in poorly designed equipment, and sadly the psychologist has to train people to cope with such problems. In some cases such training may be difficult and time-consuming and require extra training resources. In this situation, the types of errors and their associated consequences both before and after any ergonomic or training intervention need to be carefully weighed. Some errors may be tolerable, whilst others may be catastrophic. Hence there is a close relationship between ergonomics and training.

Changes in selection criteria also may offer a solution to a performance problem. Selecting people either with higher aptitudes or abilities or with previous training in related skills may improve job performance. This issue will be partly discussed in Section 4.3 since the nature of the trainees selected will affect both the content and design of training. It is often the case that some combination of the three approaches – ergonomic, selection and training – needs to be adopted to produce a viable solution. It is therefore inappropriate to consider training in isolation from other types of intervention.

The training system is only part of a larger system which might be a company or organisation. Training requires resources which in turn have to be justified in terms of projected benefits. The development of training in the workplace will face practical constraints besides the limitations of our psychological expertise in devising an optimal training situation. An excellent training programme may fail in an organisation because it takes too long to devise or is too costly. Existing simulators may have to be used for training even though they are out-of-date. In a difficult economic climate an organisation's training budget is often the first to suffer arguably because the effects of such reductions are less visible than other cuts. Indeed it is easy to underestimate the resources required for training as is evident from many evaluation studies.

The costs of training include:

(a) Buildings and land, e.g. rent, maintenance and depreciation.
(b) Capital equipment, e.g. maintenance and depreciation of training equipment, simulators.
(c) New materials required for training.
(d) Cost of trainees participating in training, e.g. salary, time.
(e) Costs of instructors, trainers and any administrative staff.
(f) Training development costs, e.g. development of intelligent computer-assisted instruction, training of trainers.
(g) External course fees.

The benefits of training include:

(a) Improved job performance, e.g. quality and quantity of production.
(b) Improved safety standards.
(c) Less absenteeism, higher job satisfaction and improved managerial and trainee attitudes.
(d) Indirect consequences of improved job performance include, e.g. increased sales and reduced need for servicing of products.

A similar perspective of training is given in Figure 4.1 from Annett (1968). Resources for training can be broadly divided into manpower and physical resources. These determine the nature of the trainees and instructors, what task will be used for training, the type of training

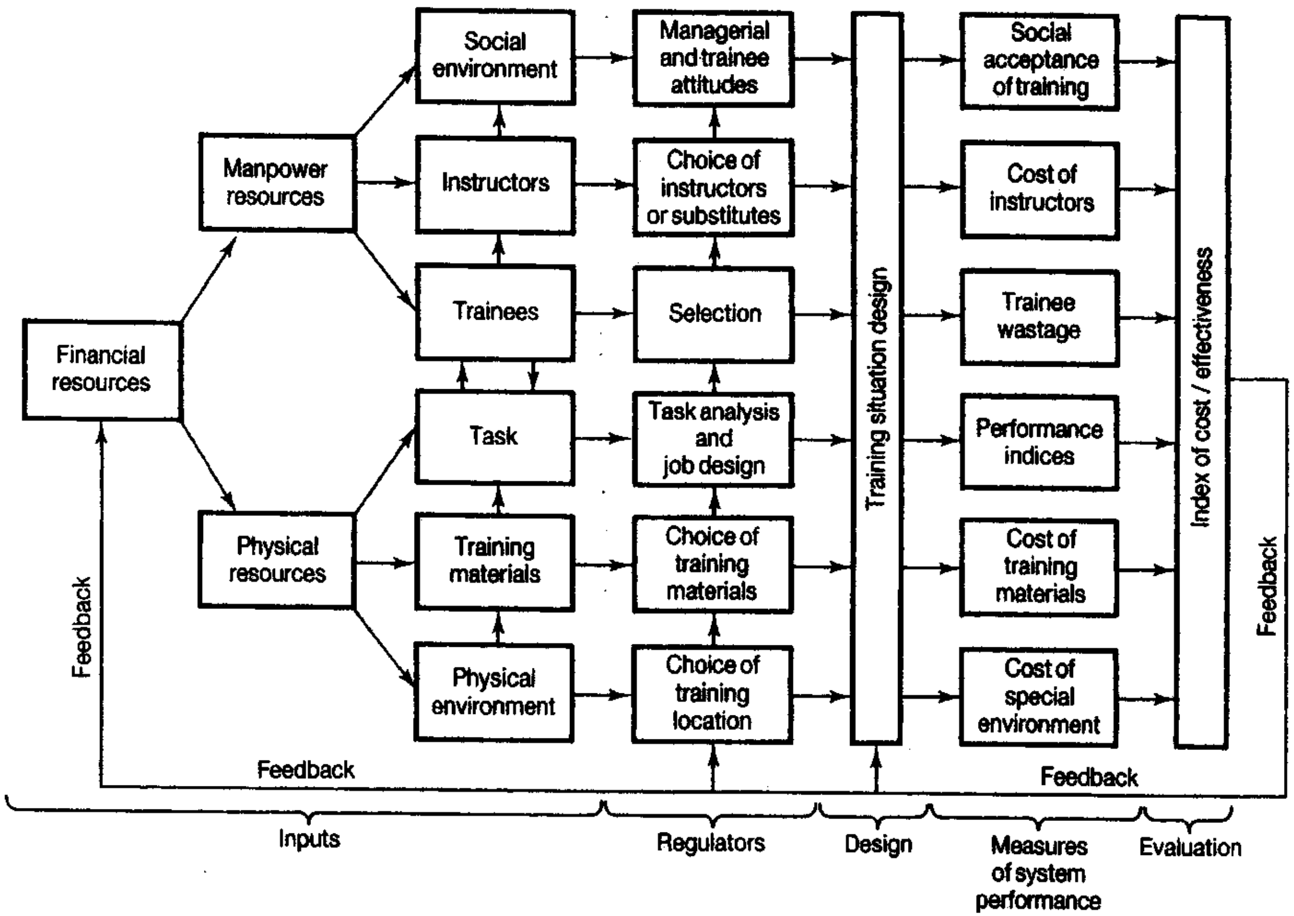

Figure 4.1 Outline of the training system (Annett, 1968).

materials and where training takes place. These, in turn, give rise to what Annett terms the "regulators" of the training system such as managerial and trainee attitudes, selection policy and choice of training location. Training is then designed and the effect of a training programme can be measured by indicators ranging from performance levels to costs and social acceptance of the training. Feedback from the evaluation phase will modify parts of the training system to improve its efficiency. Therefore the context of training is very important. The designer or manager of training is unlikely to have sufficient control over either the inputs or regulators of the training system and possibly even the measures of system performance. Consequently, training in the real world will be a compromise between a psychologically expedient design and the resources imposed or available for this purpose.

4.3 INSTRUCTIONAL SYSTEMS DEVELOPMENT (ISD) MODELS

A systems approach can identify different subsystems in the development of training, how they interrelate and the functions they perform. This has given rise to what are known as Instructional Systems Development (ISD) models. Distinctions made by these ISD models are *logical* in nature rather than *psychological* since the components of these models are specified in terms of their prescribed goals. There are many ISD models. Logan (1982) stated that Montemerlo and Tennyson (1976) found more than 100 manuals containing such models since 1951, whilst Andrews and Goodson (1980) identified over 60 such models.

The ISD approach is an attempt to analyse the development of training into a series of goals or decisions facing the training manager. Therefore ISD models can be used as job aids in the development of training. However, whilst these models specify *what* goals need to be achieved, they do not necessarily specify *how* these goals should be accomplished. For example, all models agree on the need to analyse a task and design a training programme although few are explicit about *how* this should be accomplished. These "how" decisions are essentially *psychological* in nature and are considerably more difficult than the specification of *what* has to be achieved. It should be noted, however, that some ISD models have been linked to psychological guidelines which can be used by the training manager.

Four ISD models are discussed below:

1. A model from Patrick (1980), adapted from Eckstrand (1964), which defines the major components in training development.
2. Interservices Procedures for Instructional Systems Development

(IPISD) (Branson et al., 1975; Branson, Wagner and Rayner, 1977) which was developed within the US military to improve the development of training material.

3. A model developed by Briggs and Wager (1981) in an educational context which proposes 15 stages in the design of instruction.
4. The Learning Systems Development (LSD) model (Patrick, Michael and Moore, 1986) developed within an industrial context and a hybrid of other models.

Adaptation of Eckstrand's (1964) training system

In Eckstrand's adapted training system (Figure 4.2), there are six major functions associated with the development of training. The first requirement is to identify some actual or potential problem or need within an organisation (1). This may be a result of the introduction of new equipment, staff redeployment, the development of new or more complex work or unacceptable levels of performance in terms of quality or quantity. We will assume that the optimal solution involves training or retraining personnel. It is then necessary to specify this need in terms of clear and unambiguous behavioural or performance objectives which form the goals of the training programme (3) (see Section 4.5). This in turn will enable appropriate criterion measures (6) to be developed which can be used to evaluate trainees' performance as "graduates" of the training programme.

Some analysis of the job or task has to be undertaken in order to define the training objectives (3) and to derive appropriate training content for these objectives to be met (4). This topic will be dealt with in Chapters 5–8. The final stage before running the training programme is the design of training in its widest sense (5). This covers the more important and "deep" design issues of structuring and sequencing the training materials and also the "surface" issues of how the training is delivered and presented. The psychologist therefore has to synthesise and bring to bear as many psychological principles as possible to the design of the training programme. Considerable ingenuity is required to engineer an effective training environment. The transition from training content to efficient training design has been acknowledged as notoriously difficult by many writers (e.g. Resnick, 1976; Wheaton et al., 1976). As a last resort some research may be needed to find the optimal training design. Finally, as can be seen in Figure 4.2, the trainees undergo training and emerge as "graduates" of the programme.

Any training development system should be capable of regulating itself by modifying and improving any of its subsystems. This can be achieved on the basis of feedback (7) which stems from an evaluation of the training programme via its "graduates". Amongst the most important evaluation indices is whether the trainees achieved the criterion performance. Feedback may result in modifications to the selection criteria, the training objectives, training content or any aspect of the design of the training programme. Indeed if trainees fail to develop an acceptable level of expertise, then it can be argued that it is the training development system which is at fault rather than those who receive training. Evaluation of training is discussed in Chapter 13. In this adaptation of Eckstrand's system, the personnel selection function (2) is represented in Figure 4.2. There are two reasons for this. Firstly, in the present industrial and economic climate the issue is not so much training or selection but selection for retraining (given the level of unemployment and the rapidly changing job demands). Secondly, this results in an important trade-off between selection and training. How do we decide which trainees to select for training if there is a pool of potential trainees? To answer this question it is necessary to estimate what might be termed their transferability to the new job (Patrick, 1980). Some

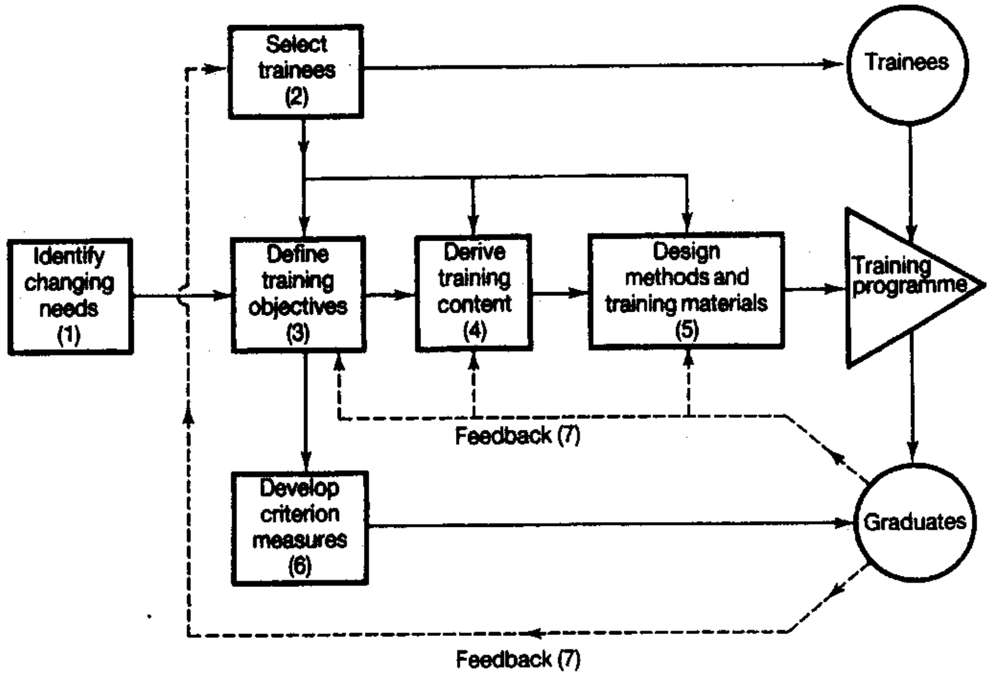

Figure 4.2 Relationships between training and selection decisions in the training system (Patrick 1980, adapted from Eckstrand, 1964).

indicators of transferability are concerned with extraneous factors in the work environment and the motivation and interests of the trainees, e.g. pay scales, status of job. Other aspects of transferability are more psychological in nature and relate to the interaction between the person's existing knowledge and skills and those which have to be acquired via the training programme. The selection decision affects both the objectives (3) and content (4) of training and its subsequent design (5).

Imagine that there are two potential trainees (A and B) for a new job. On a simple quantitative measure, trainee A already has competence in 75% of the new job's areas whereas trainee B has only 25%. Therefore trainee B has more training objectives and content to master than trainee A. However, it is not necessarily the case that trainee A has a higher transferability estimate than trainee B. Any statement of training need should also include some qualitative index of the psychological requirements imposed by the new job and the training conditions required. An examination of the 25% of the job to be mastered by trainee A might reveal the need for innovative problem-solving skills which trainee B might already have, albeit from a different context. In transferability terms, it might be cost-effective to select trainee B with such experience or capacities and little direct job experience rather than trainee A with no proven problem-solving capacity. Transferability therefore has to be estimated in the selection decision (2) by considering training costs in the widest sense of the term, e.g. time required to learn, training equipment etc.

The general advantages and disadvantages of a systems approach to the development of training are discussed in Section 4.4. One important benefit of such an approach is specification of the links between functions required in the development of training. The systematic identification of a (training) need and specification of training objectives is the first step in the training development cycle. If these are not identified accurately then it follows that the subsequent training content will be inappropriate. Therefore information associated with each training function not only has to be gathered systematically (e.g. using analytical techniques) but also has to be related directly to the subsequent activity in the development cycle. Hence needs, objectives and training content (1, 3 and 4, Figure 4.2) should map directly onto each other. Every piece of training content should be capable of being justified with respect to its training objective. Similarly the criterion measures (6) should be directly linked to these objectives. Not surprisingly, if such a modus operandi is not adopted, then training can easily become inappropriate. For example, training might be devised for a nonexistent task or training objectives may fail to represent a performance need.

Interservices Procedures for Instructional Systems Development (IPISD) (Branson et al., 1975)

The IPISD model is probably the most well-known and influential ISD model. It was developed in the context of US military training (Branson et al., 1975; Branson, Wagner and Rayner, 1977). The intention was to disseminate principles concerning the development of training which were considered to be common to different training problems and contexts. Eventually the model, which is detailed in five large manuals, was adopted by all of the American services. Since these references (given at the end of this chapter) are not immediately accessible, the interested reader will find summaries in Logan (1978, 1979).

The IPISD model (Figure 4.3) divides the development of training into five main phases: analyse, design, develop, implement and control. These are further divided into a total of 19 subphases. The executive summary describes the five phases as follows:

> *Phase 1, Analyse.* Inputs, processes and outputs in Phase 1 are all based on job information. An inventory of job tasks is compiled and divided into two groups: tasks not selected for instruction and tasks selected for instruction. Performance standards for tasks selected for instruction are determined by interview or observation at job sites and verified by subject matter experts. The analysis of existing course documentation is done to determine if all or portions of the analysis phase and other phases have already been done by someone else following the ISD guidelines. As a final analysis phase step, the list of tasks selected for instruction is analysed for the most suitable instructional setting for each task.
>
> *Phase 2, Design.* Beginning with Phase 2, the ISD model is concerned with designing instruction using the job analysis information from Phase 1. The first step is the conversion of each task selected for training into a terminal learning objective. Each terminal learning objective is then analysed to determine learning objectives and learning steps necessary for mastery of the terminal learning objective. Tests are designed to match the learning objectives. A sample of students is tested to ensure that their entry behaviours match the level of learning analysis. Finally, a sequence of instruction is designed for the learning objectives.
>
> *Phase 3, Develop.* The instructional development phase begins with the classification of learning objectives by learning category so as to identify learning guidelines necessary for optimum learning to take place. Determining how instruction is to be packaged and presented to the student is accomplished through a media selection process which takes into account such factors as learning category and guideline, media characteristics, training setting criteria, and costs. Instructional management plans are

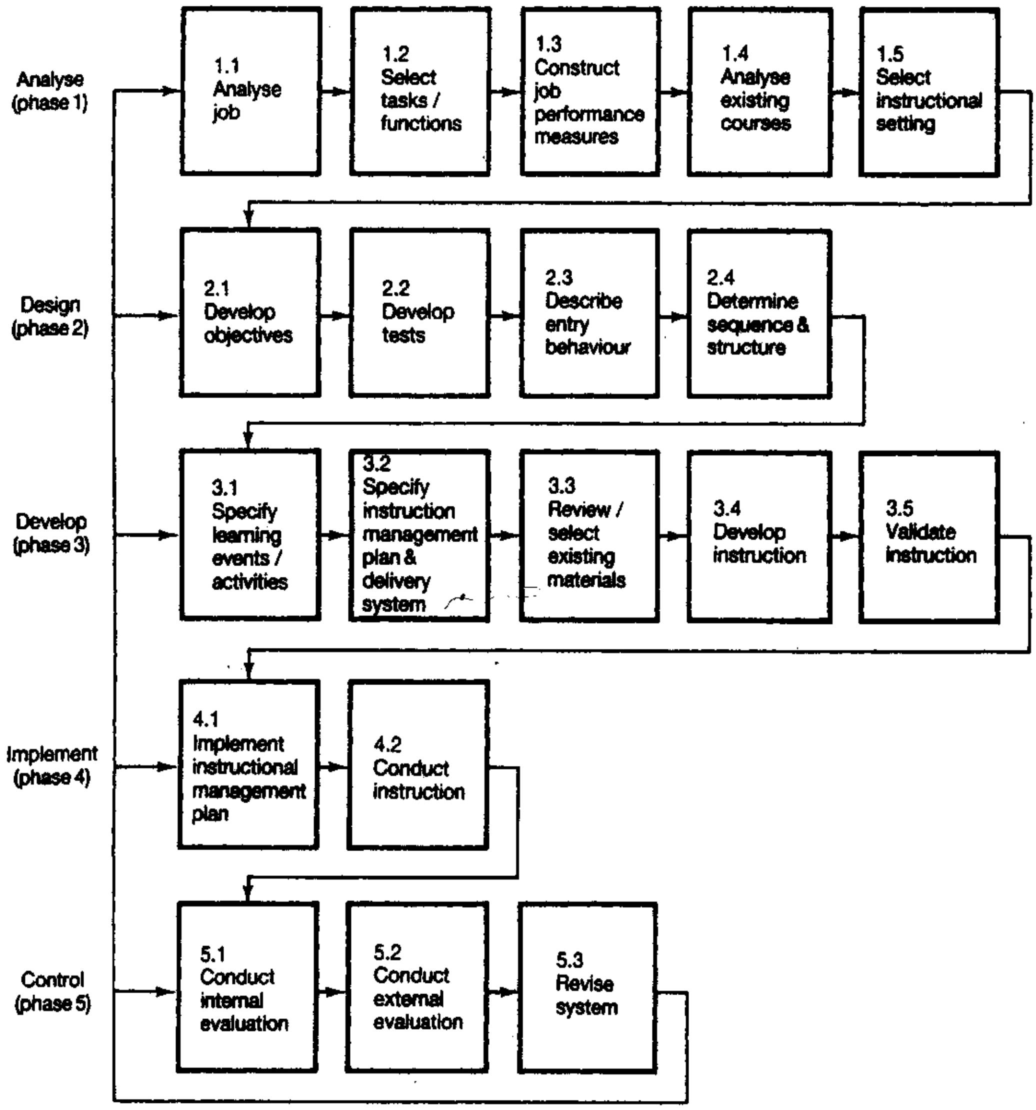

Figure 4.3 Summary of IPISD model (Branson et al., 1975, 1977).

developed to allocate and manage all resources for conducting instruction. Instructional materials are selected or developed and tried out. When materials have been validated on the basis of empirical data obtained from groups of typical students, the course is ready for implementation.

Phase 4, Implement. Staff training is required for the implementation of the instructional management plan and the instruction. Some key personnel must be trained to be managers in the specified management plan. The instructional staff must be trained to conduct the instruction and collect evaluative data on all of the instructional components. At the completion of each instructional cycle, management staff should be able to use the collected information to improve the instructional system.

Phase 5, Control. Evaluation and revision of instruction are carried out by personnel who preferably are neither the instructional designers nor the managers of the course under study. The first activity (internal evaluation) is the analysis of learner performance in the course to determine instances of deficient or irrelevant instruction. The evaluation team then suggests solutions for the problems. In the external evaluation, personnel assess job task performance on the job to determine the actual performance of course graduates and other job incumbents. All collected data, internal and external, can be used as quality control on instruction and as input to any phase of the system for revision (Branson et al., 1975, preface).

The IPISD model is more detailed than Eckstrand's adapted training system discussed previously. In the IPISD model the derivation of training content and the subsequent design of training is split into a further series of functions or stages which have to be performed by the training developer. The reader should not be alarmed at the apparent discrepancies amongst these two and other ISD models. Each model shares the same general goal, which is the development of effective training. However, the sizes into which this cake is cut varies as does the labelling of the pieces. The number of stages in a model depends upon the level of description used and the nomenclature varies with the training context and preference of the ISD designer. Differences between ISD models are more superficial than they might, at first, appear and therefore should not be treated dogmatically. Rather, ISD models should be viewed as providing a framework and series of useful prompts in the development of training.

A general criticism of the ISD approach is that whilst some generalisable stages in the development of training are specified (i.e. *what* has to be achieved), prescriptions concerning *how* these are to be accomplished are not as readily available. In order to proceduralise the development of training fully, it would be necessary to link techniques or procedures to each stage specified in an ISD model. Training programmes could then be developed by those unfamiliar with training, or indeed by automated devices. Considerable efforts have been made in this direction with the IPISD model, although they have met with limited success. Logan (1978, 1979), who is an enthusiast of the IPISD model, has carried out large scale surveys of which techniques or procedures (sometimes referred to as author aids) can be used for different functions in the IPISD model. Not surprisingly for some it is difficult to prescribe which technique or procedure should be used under what circumstances, whilst for others, very few techniques exist. Such techniques vary in terms of their reliability and validity and also in terms of whether they transfer between different training contexts. For example, it is possible to specify guidelines on how to write multiple choice questions which are reasonably generalisable. On the other hand, prescribing the design of a simulation for training is more problematic and will depend heavily upon the nature of the task to be trained.

Author aids for the IPISD model are described by Logan (1978, 1979) and O'Neil (1979a, b). This includes work by O'Neal, Faust and O'Neal (1979) who described a training course for authors of training materials which included classifying training objectives and designing the training of rules, concepts and procedures. Computerised aids which have been developed for functions 2.2 and 3.4 of the IPISD model (Figure 4.3) support the development of tests (e.g. in terms of reliability and validity) and training materials (e.g. in terms of reading level of audience, type of feedback provided). In a similar vein, Conoley and O'Neil (1979) discussed the construction of good and poor test items (e.g. multiple choice) and provided a set of guidelines for those developing such training materials. Taylor (1979) and Harris (1979) described computer-based systems which were designed to facilitate the design of training and the preparation of lessons.

These efforts to support training development are undoubtedly useful. They are nevertheless either limited to relatively small parts of the overall design process (e.g. test item development) or fail to cover important design issues in sufficient depth. It is not surprising that we cannot proceduralise the development of training, since a complete psychology of training does not yet exist. Consequently, it is important that the relevant knowledge base of psychology from which guidelines might be generated is understood by those involved in training. This is, of course, the raison d'etre for this book.

Briggs and Wager's (1981) ISD model

Briggs and Wager (1981) presented a model for training development which is couched more in the language of classroom teaching. The model consists of the following 15 functions or stages.

1. Assessment of needs, goals and priorities.
2. Assessment of resources, constraints and selection of a delivery system.

3. Identification of curriculum and course scope and sequence.
4. Determination of gross structure of courses.
5. Determination of sequence of unit and specific objectives.
6. Definition of performance objectives.
7. Analysis of objectives for sequencing of enablers.
8. Preparation of assessments of learner performance.
9. Designing lessons and materials:
   instructional events;
   media;
   prescriptions (utilising appropriate conditions of learning).
10. Development of media, materials, activities.
11. Formative evaluation.
12. Field tests and revision.
13. Instructor training.
14. Summative evaluation.
15. Diffusion and operational installation.

These functions or stages are listed in the approximate order in which they should be performed, although the authors noted that there will be iteration between most of them as materials are developed and finalised. Formative evaluation, stage 11, involves pilot testing of the materials in various ways which may lead to modification in the preceding stages. Despite the differences in nomenclature and number of stages between this model and the IPISD approach, both essentially cover the same ground. The IPISD model is more concerned with the occupational context of jobs and tasks, whereas Briggs and Wager's model emphasises the education context. Both models proceed from an assessment of training needs to a specification of objectives and to the subsequent design/development of training materials. Both models also emphasise that training materials should be evaluated both prior to and after the training programme.

Briggs and Wager (1981) have written a handbook whose chapters instruct the reader on different stages of their model.

Learning Systems Development (LSD) model (Patrick et al., 1986)

The LSD model has three phases: analyse, design/develop and implement/control. These phases are broken down into the tasks facing the training designer: five tasks in the analyse phase, four tasks in the design/develop phase and three tasks in the implement/control phase (see Figure 4.4). In addition the design and development phase,

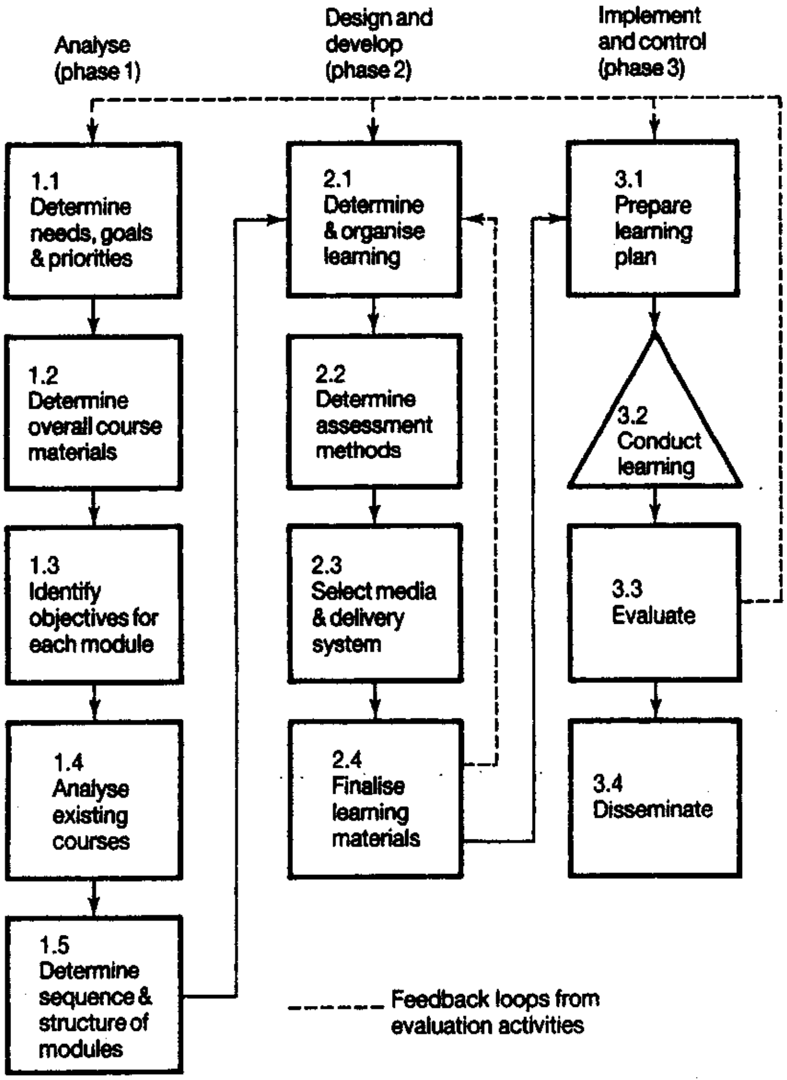

Figure 4.4 Learning Systems Development (LSD) model (Patrick et al., 1986).

involving four tasks, is further subdivided into a total of 14 subtasks. Each subtask in the design/develop phase has an associated set of guidelines for the practitioner which describe, for example, how to identify types of learning, structure the learning material and optimise presentation.

4.4 ADVANTAGES AND DISADVANTAGES OF ISD MODELS

Four ISD models have been reviewed in Section 4.3. The general nature of this systems approach to the development of training should now be evident and its overall benefits and shortcomings will now be addressed.

The advantages of an ISD approach are:

(a) *ISD models identify generalisable functions in the development of training.* An ISD model views the development of training as a system and breaks it down into subsystems and the functions they perform. Terminology varies and sometimes these subsystems are described as phases, stages, goals, functions, components or tasks. Irrespective of how they are labelled, the important point is that each function has to be performed in the development of *any* training programme. Hence ISD models claim to be general purpose or context independent.

(b) *ISD models are helpful to those unfamiliar with training development.* Any ISD model prescribes the functions involved in training development together with the sequence in which they should be carried out. Hence such a model can be an aid to those with little knowledge of how to develop training systematically.

(c) *ISD models are particularly useful to large-scale organisations.* In large military, educational or business establishments, there are many jobs which require training. As a result, various people may be involved in training development activities for even the same job. An ISD model not only enables a sensible division of labour to take place but also facilitates coordination of these training activities, since the output of one subsystem is the input to another. It is no coincidence that large military and educational organisations have been at the forefront of development of such ISD models.

(d) *Psychological principles can be appended.* The Briggs and Wager and LSD models discussed in Section 4.3 have psychological principles, techniques etc. directly linked to the different functions in the models. To a lesser extent this is true of the IPISD model. Such models therefore make it easier to organise and target relevant psychological findings with respect to the training functions to which they apply. It was mentioned in Chapter 1 that the chapters in this book reflect three major ISD functions: analysis (Chapters 5–8), design (Chapters 8–12) and evaluation (Chapter 13).

(e) *An ISD model can be used as an evaluation framework.* Training can be evaluated by not only examining the product(s) of training, but also the *process* of training development. Legitimate and revealing questions are: how many ISD functions were addressed explicitly in the development of this training programme? How were these functions accomplished and which, if any, techniques or psychological principles were involved? Consequently an ISD model can provide a framework for the evaluation of *how* training was developed.

The disadvantages of an ISD approach are:

(a) *It is an idealised, top-down view of training development.* ISD models arguably present a too idealistic perspective and obscure training development activities which are often idiosyncratic (e.g. Bunderson, 1977). Whilst moving from a specification of training needs and objectives to the design, development and evaluation functions is the rational approach, even those expert in training may deviate from this linear top-down sequence.

(b) *ISD models specify "what to do" rather than "how to do it".* As we discussed in Section 4.3, ISD models themselves do not provide detailed prescriptions or guidelines of how the training functions should be performed. They are skeletons without flesh.

In conclusion, it is evident from the above advantages and disadvantages that on balance, an ISD approach is of benefit. It is not suggested that any one model should be followed slavishly. Also the use of any model does not guarantee the development of good training. Nevertheless, an awareness of the functions involved in developing training and how they inter-relate provide an important framework for those engaged in devising training programmes.

4.5 TRAINING OBJECTIVES

The specification of training objectives is an important first step in the development of training, as we have seen from the various ISD models. Training objectives determine both the content and design of training and also what trained persons should be able to accomplish after training. A massive literature exists concerning the writing and use of different types of objective in the design of training (e.g. Davies, 1976; Tyler, 1950). Mager (1962) provided the classic account of developing objectives which, he argued, are primarily for communicating instructional intent. Objectives should have three components:

> *First*, identify the terminal behaviour by name; you can specify the kind of behaviour that will be accepted as evidence that the learner has achieved the objective.

> *Second,* try to define the desired behaviour further by describing the important conditions under which the behaviour will be expected to occur.
>
> *Third,* specify the criteria of acceptable performance by describing how well the learner must perform to be considered acceptable (Mager, 1962, p. 12).

An example provided by Mager of an objective is:

> Given a DC motor of ten horsepower or less that contains a single malfunction, and given a standard kit of tools and references, the learner must be able to repair the motor within a period of 45 minutes (p. 39).

Mager therefore prescribed that objectives are tightly linked to performance requirements and should specify the actions which the trainee should be able to perform after training, the conditions under which these actions are to be performed and the standards of performance which must be met. Merrill (1983) has extended Mager's formulation for the specification of objectives by detailing generic forms of objectives for different types of learning in his Component Display Theory. This theory of instruction is discussed in Chapter 8.

Gagné and Briggs (1974) have proposed five components for writing objectives which overlap with those proposed by Mager and include specification of the situation, the object, the action, the tools and other constraints and the capability to be learned. Gagné and Briggs provided the following example of how a typist's task of copying a written letter can be specified by these five components:

Given a written longhand letter	(Situation)
executes	(The learned capability, a motor skill)
a copy	(Object)
by typing	(Action)
using an electric typewriter making one carbon of a one page letter	(Tools and other constraints)

(Gagné and Briggs, 1974, p. 81.)

Such guidelines for writing adequate objectives are useful but do not guarantee good training. It is unfortunate that many courses concerned with training go little further than emphasising the role of objectives and the use of Mager's guidelines and fail to consider other equally important training issues. MacDonald-Ross (1973) criticised the excessive prominence given to behavioural objectives in the development of training. Firstly, as MacDonald-Ross asked, what are the origins of such objectives? How are they generated and selected as being relevant to a training programme? Such questions are difficult to answer systematically, although some analysis techniques (e.g. Hierarchical Task Analysis, Chapter 6) arguably provide an answer. Naturally, performance objectives for a training programme should correspond as closely as possible to those which occur in performance of the real task or job. Secondly, objectives depend upon the use of verbs to describe performance. These should be concrete (Duncan, 1972) and action-oriented (Gagné and Briggs, 1974). This will reduce the ambiguity inherent in such verbs as "to know" or "to understand", although, of course, ambiguity can never be totally eliminated. It is recommended therefore that when performance objectives are being developed during the analysis of a task or job, a set of action verbs should be defined. Such an approach was adopted by Frederickson and Freer (1978) in a study of the basic electronic skills of maintenance personnel. They provided a list of twelve action verbs which make distinctions in maintenance functions with associated definitions. This at least restricts the room for ambiguity. For example:

Inspect: To determine the serviceability of an item by examining its physical, mechanical and/or electrical characteristics and comparing these measurements with established standards.

Adjust: To bring an operating characteristic of an item into prescribed limits by setting variable controls to the specific, proper or exact positions (Frederickson and Freer, 1978, p. II–6).

In our discussion of ISD models, we found that training functions were specified in terms of goals without the means of achieving them necessarily being made explicit. A similar criticism can be made of behavioural objectives. If objectives are associated with simple perceptual-motor tasks, this may present less of a problem since there may be few alternative methods which the trainee can use to achieve such objectives. On the other hand, when these objectives refer to complex and/or cognitive activities, the number of different strategies for achieving them will increase. For example, diagnosing faults in a car engine might involve pattern matching of symptoms, use of an algorithm, use of heuristics or qualitative reasoning from first principles concerning the cause and effect relationships of variables (e.g. fuel, electricity) used in the operation of the car. The psychological demands of this task and also the necessary training will vary immensely depending upon which strategy or combination of strategies the fault-finder has to master to achieve the objective of fault-finding. Consequently, the use of training objectives needs to be linked to some psychological analysis of the nature of the task which is to be trained. These issues are explored in Chapters 7 and 8.

The objectives of training affect both the content and design of

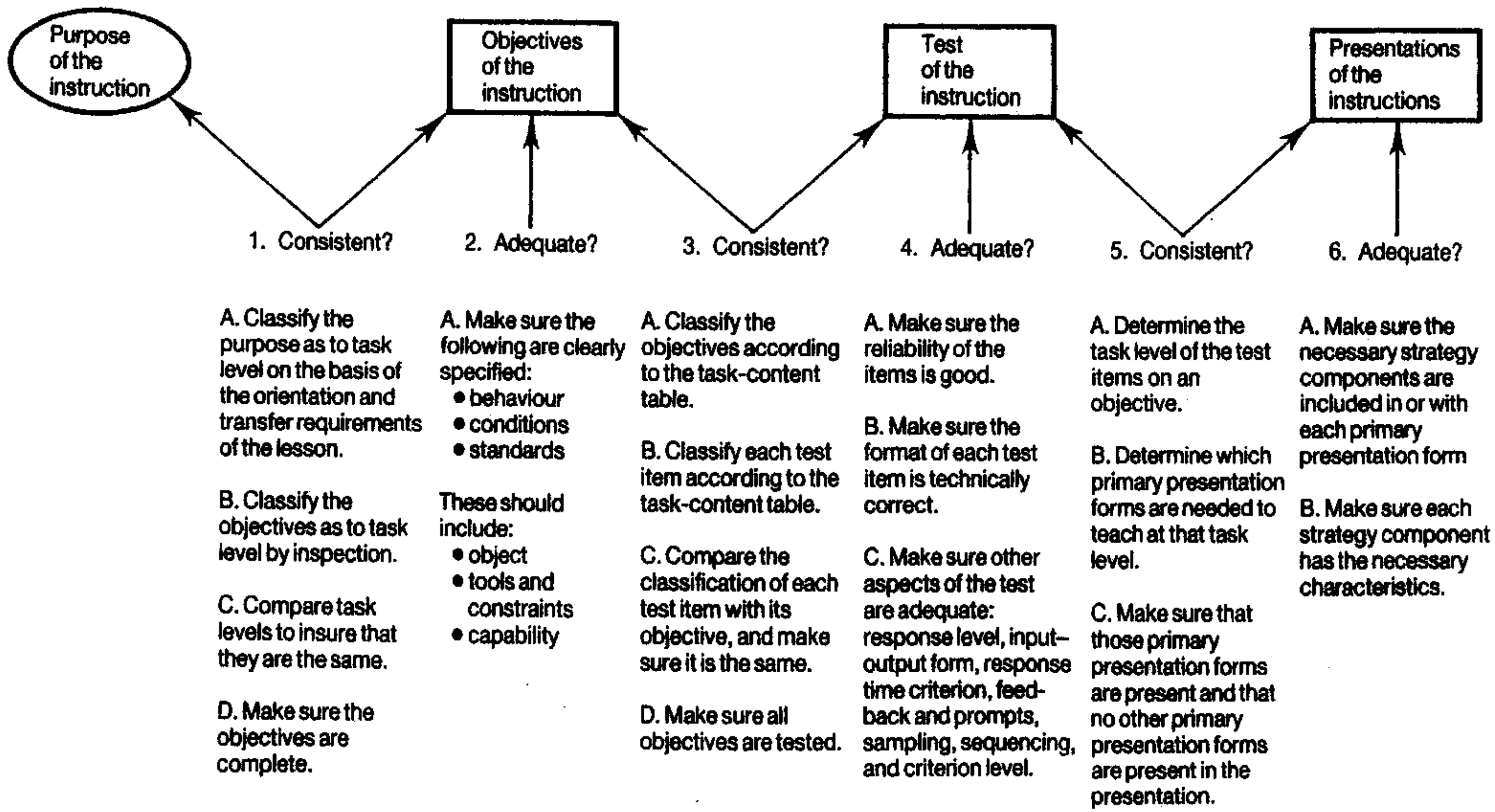

Figure 4.5 A summary of the aspects of instructional quality analysed by the Instructional Quality Profile (Merrill et al., 1979).

training. Therefore the mapping between such objectives and other components of an ISD model should be consistent. To this end, a major research effort by the Navy Personnel Research and Development Center (NPRDC), San Diego, developed procedures for ensuring that training objectives, training tests and training materials (called instructional presentations) are not only adequate but also consistent with each other. Initially the technique was named the Instructional Strategies Diagnostic Profile (ISDP) (Merrill et al., 1977) and was aimed at assessing the quality of training materials. After evaluation and some revision it was renamed the Instructional Quality Inventory (IQI) (Ellis et al., 1978) and also the Instructional Quality Profile (Merrill, Reigeluth and Faust, 1979). Subsequent manuals published by NPRDC (e.g. Ellis, Wulfeck and Fredericks, 1979) detail the procedures associated with the IQI. Unfortunately, these references are not easily accessible and therefore the interested reader is referred to a summary of the role and scope of the Instructional Quality Profile by Merrill et al. (1979). The technique is aimed at ensuring that different aspects of training are consistent and adequate from both logical and technical perspectives. Figure 4.5 provides an overview of this technique which can be broken down into six areas:

1. *Purpose – objective consistency*. Are the training objectives consistent with the aim of the training programme?
2. *Objective adequacy*. Are the training objectives adequately stated? This can be tested using Mager's prescriptions.
3. *Objective – test adequacy*. Are the tests of pre- or post-training performance valid? In other words, are they measuring the skills, knowledge, etc. specified by the training objectives?
4. *Test adequacy*. Are the tests reliable and well constructed? There are many guidelines for constructing good tests in both the training and educational literature.
5. *Test – presentation consistency*. Do the training materials provide the appropriate skills, knowledge, etc. for trainees to perform as required in the post-training test? (Note "presentation" refers to the presentation of information in training, i.e. training materials.)
6. *Presentation adequacy*. Are the training materials well constructed to promote the required training?

The application of such principles to both the design and evaluation of training has considerable merit.

Finally, objectives are not only helpful to the developer or designer of training, but also to the trainee if they are provided at the outset of training. Hartley and Davies (1976) summarised 40 studies which evaluated the improvement in learning by giving trainees behavioural objectives prior to training. They concluded that, despite methodological differences and a lack of agreement on the level of detail of such objectives between evaluation studies, it is beneficial to provide the trainee with objectives before training. This, and other pretraining strategies are discussed in Chapter 9.

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