# ROTI-OPERATIONAL INSTRUCTIONAL SYSTEMS MODEL

By Lt W. H. Barker*

## Introduction

The instructional model presented here is a combination of systems used by the United States Navy and R. F. Mager's Criteria Referenced Instruction Model for Analysis Design and Implementation. The author has taken what he believes is the best components from each system and established a working model.

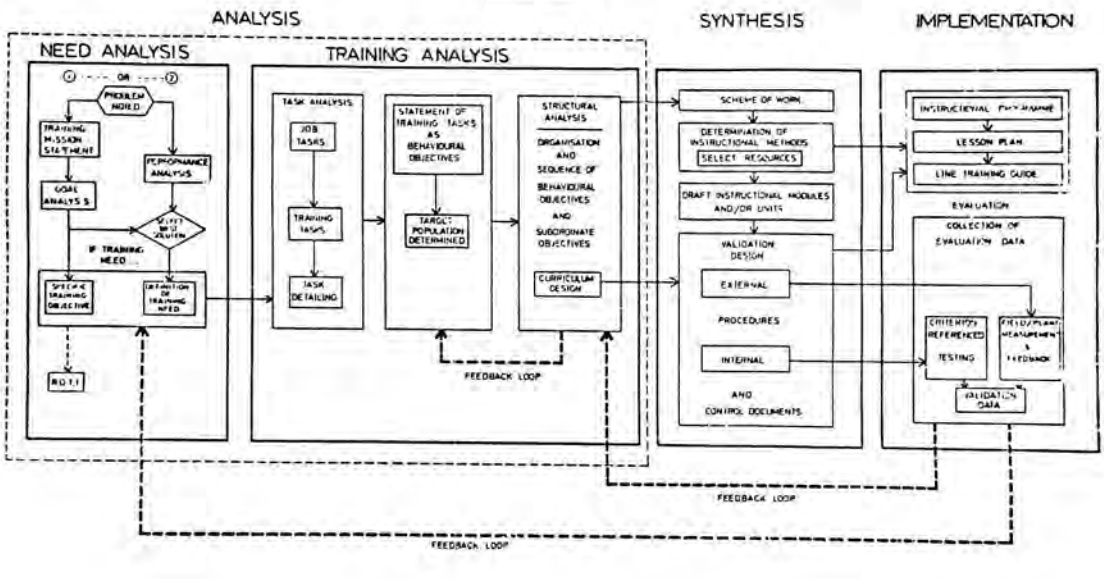
Warren Dederick serves as an educational consultant to the Naval School and in this capacity developed the original model.

It is typically a systems approach to solving problems to which the solution is definitely a training one.

The present model fig. 1 is derived from existing Naval educational policy of the U.S. Navy and of the CRI model of Course Design by Mager et al.

The model is valuable in that in its detail it can describe a single course, the organisation of a training institution or in its broadest sense a total educational system. Most important of all it describes a system now at work rather than a theoretical system. Both systems have been validated.

FIGURE 1




ROTI - OPERATIONAL INSTRUCTIONAL SYSTEM MODEL

*Describing the Model*

The model includes four major components:
1. Need analysis;
2. Training analysis;
3. Synthesis;
4. Implementation.

Vital to the system are the feedback loops to ensure that the objective is achieved.

*Need Analysis*

A need to train usually stems from two sources:
1. A new requirement to solve a particular problem.
2. A problem which is a direct result of performance descrepancy which may be rectified by training or re-training.

The first requires a clear training mission statement. Often this is defined by higher authority who have not identified in specific terms what they want to achieve as a result of a training programme. The mission statement would therefore require further analysis to determine the measurable outcome of a training programme. Goal analysis will lead to a specific measurable objective which can be achieved as a result of the training. This objective should be in such terms that it would be possible to calculate the Return of Training Investment. (ROTI).

In the second instance, where a problem is identified, it is necessary to determine whether the problem can be solved by training. 'is it really a training problem?' Is there really a training need? To establish this we require to carry out a performance analysis. R.F. Mager's method of analysing performance problems will be an excellent method of doing this. Once we have selected the best solution and have positively identified a training need we can once again relate it to a *specific training objective* which is measurable and which will allow us to calculate our R.O.T.I.

This leads us to the next major step.

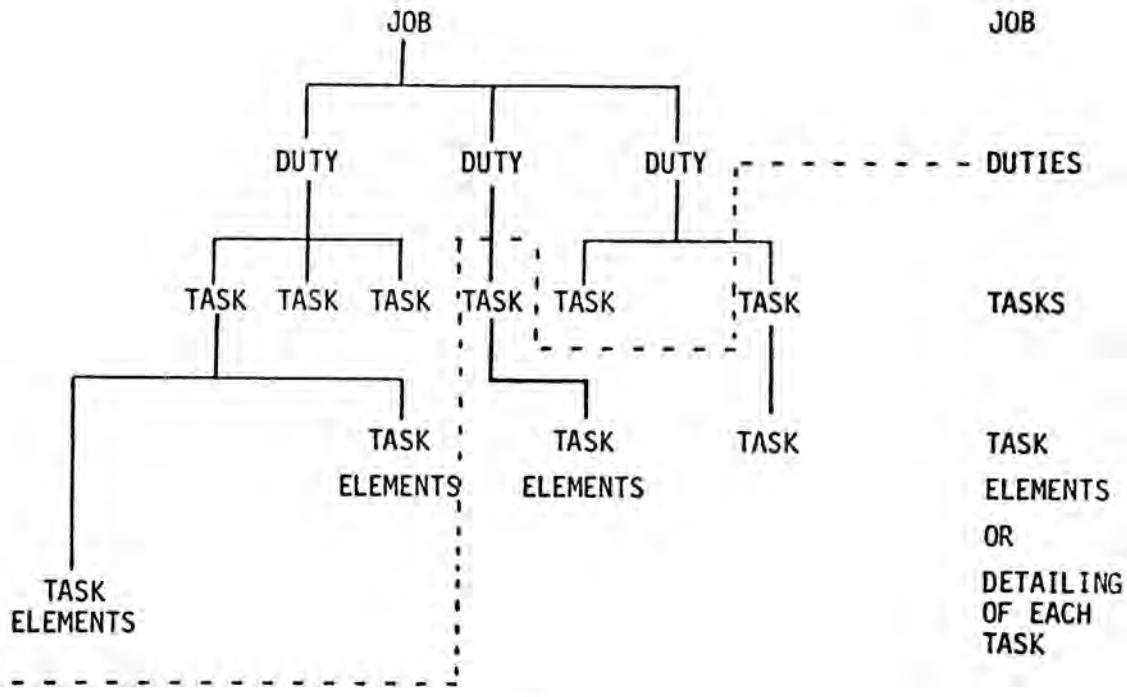
*Training Analysis*

This analysis phase involves careful examination of the job which the trainee will later be required to perform.

*Job Tasks* — The job is carefully analysed to determine the duties and tasks that are performed.

Figure 2 shows how this analysis would be done:

Figure 2



A job description can be drawn up from this as it will identify the key tasks/duties and also the 20% tasks that account for 80% time or result. (And also which of these tasks are the ones which the trainee is required to be trained in because of poor performance).

The behaviours, skills or activities necessary to do the job are identified and stated as *job tasks.* Those tasks which are selected to be taught in the course become the *training tasks.* These training tasks are further analysed in the *task detailing.* This will consist of each task element. (Figure 2).

Job tasks not included as training tasks will be specified either as pre-requisite skills or abilities for entry to the course or as competence to be gained on the job or in follow-up courses. (Below the dotted line figure 2.)

*Statement of tasks as behavioural objectives*

This step is critical in the system's development. We are speaking here of instructional objectives An instructional objective is the learning intent of the programme or section of programme and states the terminal behaviour of the trainee in performance terms. A good behavioural objective therefore states the performance expected of the trainee, the conditions under which it is to take place and the criteria or standards against which it is to be measured. (Mager 1962). It is expected that a trainee must be able to demonstrate criteria — level mastery of all the Instructional Objectives in order to perform the job satisfactorily.

Once the objectives have been completed it is possible to define the target population for the course. This is a man specification of the trainee and will contain the pre-requisite knowledge, skills or abilities which are required as the entry level for the programme.

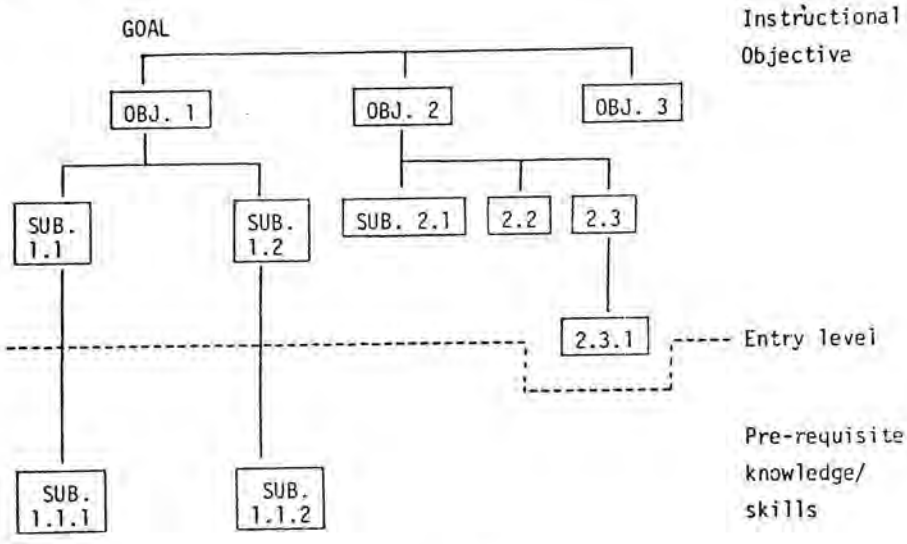
*Structural Analysis*

This means that the behavioural objectives must be organised and sequenced before the instructional programme is established. This is important as the mastery of some knowledge, skills and abilities is dependent (pre-requisite) to/on the mastery of others. Structural analysis shows the most desirable sequence so that instruction can proceed rationally and efficiently towards the accomplishment of course objectives.

In the process of structural analysis it may become clear that some behavioural objectives need revision. It may also highlight that others were omitted, specifically *subordinate objectives.* These are objectives which specify pre-requisite knowledge, skills and abilities which have to be mastered before the learner can master the required behavioural objective. Not all subordinate objectives are taught as most will be required as the entry level for the target population.

Figure 3 shows the method of determining which subordinate objectives must be taught. All the subordinates below the dotted line are considered as pre-requisite for entry level.

Figure 3



The feedback loop from Structural Analysis to Statement of Tasks as behavioural objectives provides for appropriate modifications in this case. When the structural analysis is complete we will have produced the course curriculum.

The data is now available for the next phase of this systems model.

*Synthesis*

With the instructional objectives clearly in mind, the course developer is ready to plan a programme of instruction. The constraints under which he operates must be considered: Budgeting limitations, available personnel, equipment inventory, time allocated, priority and decisions previously made by higher authority.

*Designing Scheme of Work*

The scheme of work is a clear breakdown by element and phase of each instructional objective. It states the skill and knowledge required by the trainee. Our definition of skill here is simply: 'What the trainee must be able to do', and similarly by knowledge we mean, 'What the trainee must know'. Further clarification in terms of key factors i.e. safety performance standards, quantity and quality are also listed against each element. Figure 4 gives an example.

*Determination of Instructional Methods*

Knowing what our instructional intent is and knowing who the target population is, as well as the basic skills and knowledge for each element or phase, we can now select the most effective teaching strategy. Within the above constraints, the following variables must be considered when selecting an appropriate instructional method:

a) Frequency of use of task.
b) Complexity.
c) Time available for lesson.
d) Number of people performing the task.

The necessary resources can also now be selected.

*Drafting of instructional units or modules*

This is the work done to lay out the course package. It includes all the material, instructions and resources for the trainer. It is from this that the trainer derives his lesson plan. The format of the modules or units can be written in lesson plan form at this stage as well, if so desired.

*Validation design*

A systems approach to instruction is a closed loop, self correcting process which moves from identified needs to predicted outcomes (Kauf-

OBJ. ..... TASK .....

| ELEMENT | SKILL : What the trainee must be able to do. | KNOWLEDGE : What the trainee must know. | KEY FACTORS |
|---|---|---|---|
| | | | |

Figure 4

man 1972). Validation procedures provide the feedback for self correction when necessary thus keeping the system operating effectively. Validation procedures are planned during the synthesis phase so that they can be put into immediate use during the implemented phase.

There are two forms of Validation, external and internal.

*External Validation* is derived from operations feedback. This comes directly from where the job is taking place in the field. It will determine whether the course objectives are meeting the needs of the operation and consequently, the specific training objective as specified in the need analysis. If a course has external validity, the data from the operations indicate that the graduates of that course are performing on the job satisfactorily. On the other hand, reports of unsatisfactory job performance by course graduates will set the external validation feedback loop in operation to correct any errors in the original definition of a training need. This may then necessitate changes in subsequent steps of the system.

*Internal Validation*, determines at the end of the course, whether the trainee is able to meet the objectives for which the course was designed. The focus of internal validation is on content and procedure of instruction and on criterion testing. When the course developer prepared the curriculum by writing the behavioural objectives during the analysis phase of the system, he also outlines the criterion referenced tests which will measure students performance of those objectives. Thus there are several benefits:

1) C.R. tests follow naturally from well designed objectives.
2) Validation of test items and of instruction follows in a clear and straight forward way.

Constructing the internal validation design thus requires procedures to validate the course and to make changes where the test data may indicate them to be invalid.

*Implementation*

Before the pilot course is scheduled a detailed instructional programme is to be drawn up. This would cover items such as Day, Session, Timing, Venue, Theory or Practical. The scheme of work as developed in the previous phase covers in detail the following: Element or phase, Skills, Knowledge and Key Factors. It is a very useful aid for instructors in drawing up their lesson plans.

When the course is initially implemented external validity is assumed. Therefore during the initial implementation the focus is on internal validity. These are:

1. Do the test items accurately reflect the instructional objectives? and
2. Does the training programme fully prepare trainees to pass or achieve the test items based on those objectives.

*Collection of Validation Data: Criterion referenced testing:*

A well designed criterion referenced test has the following characteristics:

1. Relevance to the course objectives.
2. Freedom from bias.
3. Reliability.
4. Availability.

A test that can be shown to have the above characteristics is considered valid. Collection of the results of student performance on the tests provide data for validation analysis.

*Analysis of Validation Data for C-R tests*

The goal of instruction (Criterion Referenced Instruction) is for all students to succeed in 100% of the test items. Therefore course managers are concerned primarily with those items which students fail. In Figure 5 we can see that the data collected as a result of pre-course and post test is quite revealing. The failures must be for one of four reasons:

1. The test item is faulty.
2. Instruction in the area tested is inadequate.
3. Students entry-level competencies were inadequate or incorrectly measured.
4. Students made errors for such reasons as lack of effort, carelessness or inattention.

The cycle of internal validation is completed when the course managers' findings have been fed back through the earlier steps. Through these steps, the systems approach to curriculum development provides for a self correcting, self renewing educational programme.

Figure 5

| STUDENTS | QUESTION NUMBERS | | | | | | | | | | TOTAL ERRORS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Pre-test | Post test |
| A SMITH | | | X | | Ⓧ | X | | | X | X | 5 | 1 |
| B BROWN | X | | | | Ⓧ | | X | | | | 3 | 1 |
| C BLACK | | | | | | | | | Ⓧ | | 1 | 1 |
| D GREEN | X | | X | | Ⓧ | | | | | | 3 | 1 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| Total errors pre-test | 2 | 0 | 2 | 0 | 3 | 1 | 1 | 0 | 2 | 1 | 12 | - |
| Post-test errors | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | - | 4 |

X Pre-test error

O Post test error

IK Davies - The organisation of Training.

*FIELD/PLANT Measurement and Feedback*

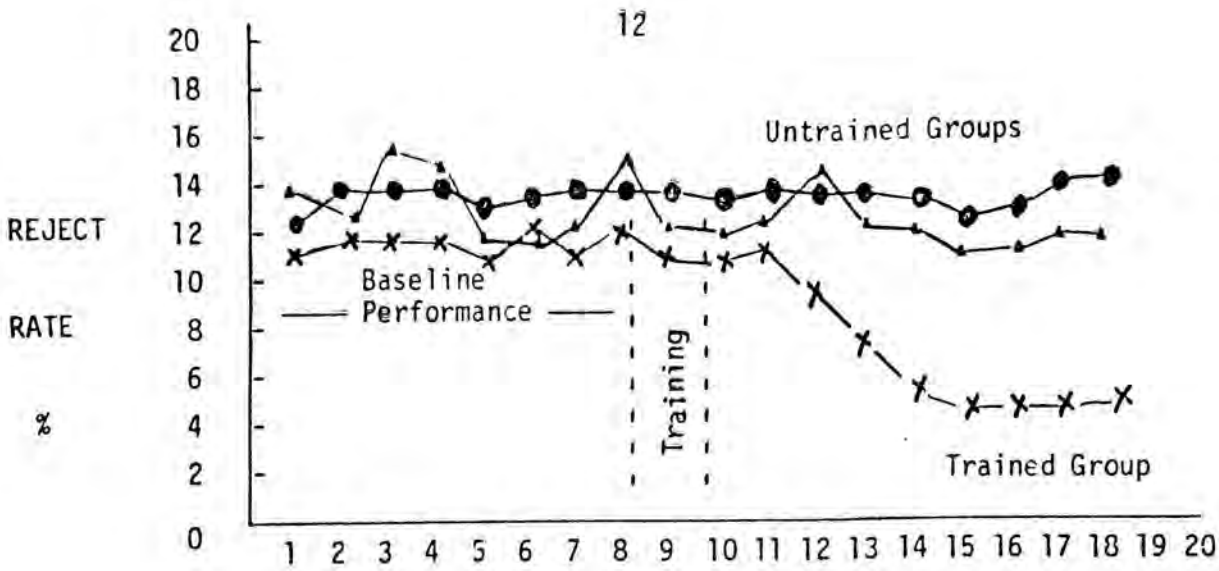
If through the pilot course the programme is found to have good *internal* validity it may be implemented fully in the field. A measuring system of actual job performance must be instituted so that comparisons can be made (in the case of a training need due to poor performance) of the results before and after the training had been given. The desired performance results should tie up with the specific training objective as stated during the need analysis.

A simple example is given in Figure 6. Here we have a measurement system, based on the specific training objective of wanting to reduce the reject percent rate. A training programme is developed for this purpose and a group is selected for the pilot implementation. Measurement procedures are set up and data is collected for external validation. This will be done over a period of time, both before and after the training. It will be noticed that after the training the pilot group's reject rate drops and levels off at about 4%. The specific training objective could not state exactly what the drop in reject rate would be, but now once the trained group's results start to level off, as shown in Figure 6, we can predict that the training programme in future will give us a drop in reject rate percent of at least about 7%. This may or may not be acceptable to management. The feedback loop will then provide the necessary modification to either the specific training objective or to modify the course so that the system can be validated for the specific training objective. Once this has been done, the return of training investment can be calculated.

Calculating the R.O.T.I. in simplest terms for the above example would be to:

1. Establish all costs for developing and running the training programme.
2. Establish the cost of 1% of rejects.
3. Calculating the cost saving of a 7% drop in reject rate.
4. Compare with costs of (1) above.

This will tell us whether the training course is cost effective and whether there is a useful return on the training investment.




**Time, Weeks**

**Figure 6. Graphic display of training effects**

In conclusion, in combining systems used by Dederick and Sturge as used in the U.S. Navy and that of R.F. Mager in his Criterion Referenced Instruction course design, we have a working systems model which will not only provide a procedure for comprehensive curriculum management, but will also provide measurable validation of training efforts to meet specific operational needs. Above all it will allow us to measure the Return on Training Investment.

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