Problem Solving in CDT

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1. INTRODUCTION

Much of school education could be related to an 'R[3]' philosophy, that is — 'Read, Remember, Regurgitate, but don't necessarily understand'. Furthermore, this approach tends to artificially isolate bodies of knowledge one from another and can have a profoundly dampening effect upon enthusiasm for learning, together with suppression of creative ability — a quality of considerable potential value. Whilst the learning of information by rote can be very useful, it does not adequately prepare a child to cope with the rigors of life and the world of work.

Much of successful living and working necessitates the satisfactory solutions of problems where bodies of knowledge and skills are interrelated. Problem solving is a practical, integrated activity, requiring interaction of the problm solver with the problem situation.

Problem solving has considerable value in education in that it initiates and stimulates an awareness of the need for the knowledge and skills to reach a successful conclusion. The undertaking of carefully selected problems within school can effect in a child:—

* an awareness of the interrelation and the integration of knowledge and of skills,
* the satisfaction of achievement resulting from solution of a real problem,
* a motivation for learning, and
* the commencement of ability to recognise and cope positively with problems in life and in the world of work.

CDT is one of the most appropriate subjects within the school curriculum to present significant opportunities for enhanced education though the practice of problem solving.

2. PROGRESS TOWARDS ACHIEVING AN ACCEPTABLE SOLUTION TO A PROBLEM

Achievement is dependent on several critical factors:—

* Problem complexity.
* Uniqueness of solution.
* The nature of type of problem.
* Dependence on the application of specialist knowledge, eg. technicality, skills.
* Facilities necessary and available for solving a particular problem eg. access to customer, availability of required specialist knowledge, workshop facilities.
* Required and available finances.
* Relevant experience of the problem solver.
* Time available.

and especially important in a primarily learning situation:—

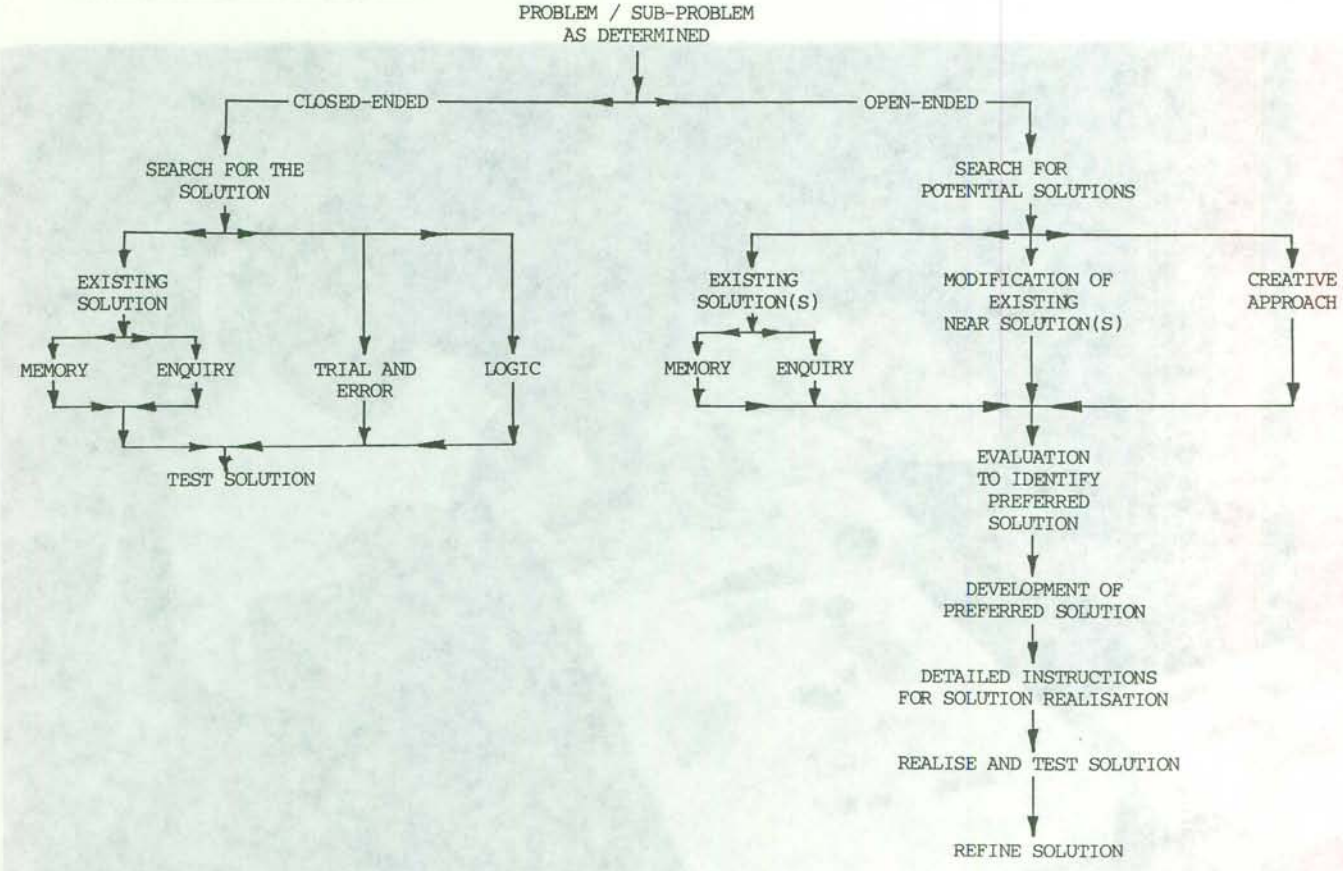

FIG.1 A SIMPLIFIED OUTLINE ILLUSTRATION OF THE PROBLEM SOLVING PROCESS

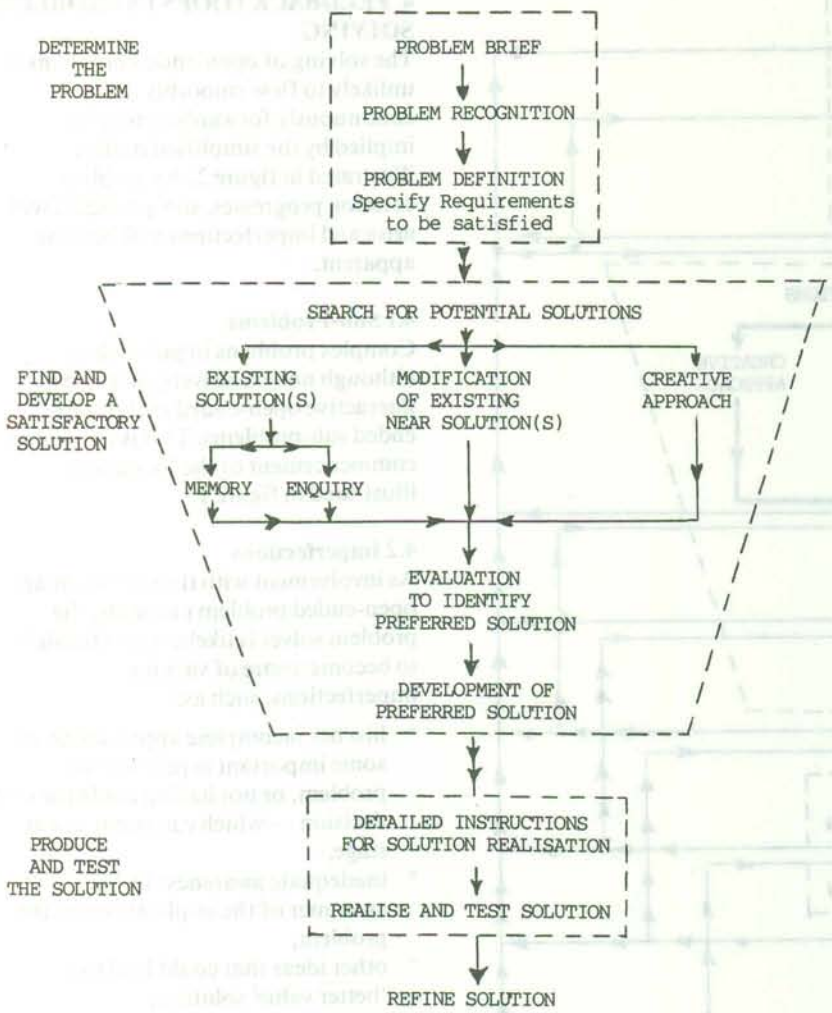

FIG. 2 A SIMPLIFIED OUTLINE ILLUSTRATION OF THE OPEN-ENDED PROBLEM SOLVING PROCESS SHOWING PRINCIPAL AREAS OF ACTIVITY

* Access to an appropriately experienced tutor.

Problem Complexity, Uniqueness of Solution and Nature of Type of Problem are described below. The other factors are considered to be relatively self-explanatory.

2.1 **Problem Complexity** can range from:—

a) SIMPLE — for which complete, precise solution is readily obtainable, eg. Determine the average speed of a motor vehicle knowing the distance travelled in a given time,

through to:

b) COMPLEX — which may defy solution for a considerable time, eg. Provide interplanetary holidays.

2.2 **Uniqueness of Problem Solution**
Problems and their identifiable sub-problems can be placed in one of two categories:

a) CLOSED-ENDED PROBLEMS — which have only one solution, eg. Determine the nominal height of a given rectangular room.
b) OPEN-ENDED PROBLEMS — which have a variety of possible solutions, eg. Find ways to determine the nominal height of a given rectangular room.

2.3 **The Nature or Type of Problem**
This relates to the essential qualities both of the problem and the means of providing its solution. The essential qualities of the problem are related primarily to its complexity, as already described. The means of providing solutions involves a number of stages, depending upon problem complexity and uniqueness of solution, as illustrated in figure 1 and described for open-ended problems in Section 3.

Providing the solution to a simple closed-ended problem is relatively straightforward. Providing an acceptable solution to a complex open-ended problem is seldom straightforward and is likely to necessitate numerous feedback loops, involving both the open-ended and the closed-ended routes, together with solution refinement. This is outlined in Section 4.

3 STAGES IN OPEN-ENDED PROBLEM SOLVING

Stages common to the effective solution of all open-ended problems are:—

a) Commencement with a Problem Brief, ie. indication (probably vague) of the existence of a particular problem.
b) Problem Recognition — involving solver enquiry of the customer and investigation into and familiarisation with the problem.
c) Problem Definition — presented as comprehensive, unambiguous and concise statements, specifying the requirements to be satisfied and/or restricting parameters — very probably necesitating close co-operation with the customer.
d) Search for Potential Solutions — both existing, development of existing 'neat' solutions and appliction of the creative approach.
e) Evaluation to identify the preferred solution.
f) Detailed development of the preferred solution, eg. for the production of engineering hardware, this would involve satisfactory determination and compatible interaction of:
   * unit and component shape and size
   * material selection and
   * economic and available manufacturing processes.

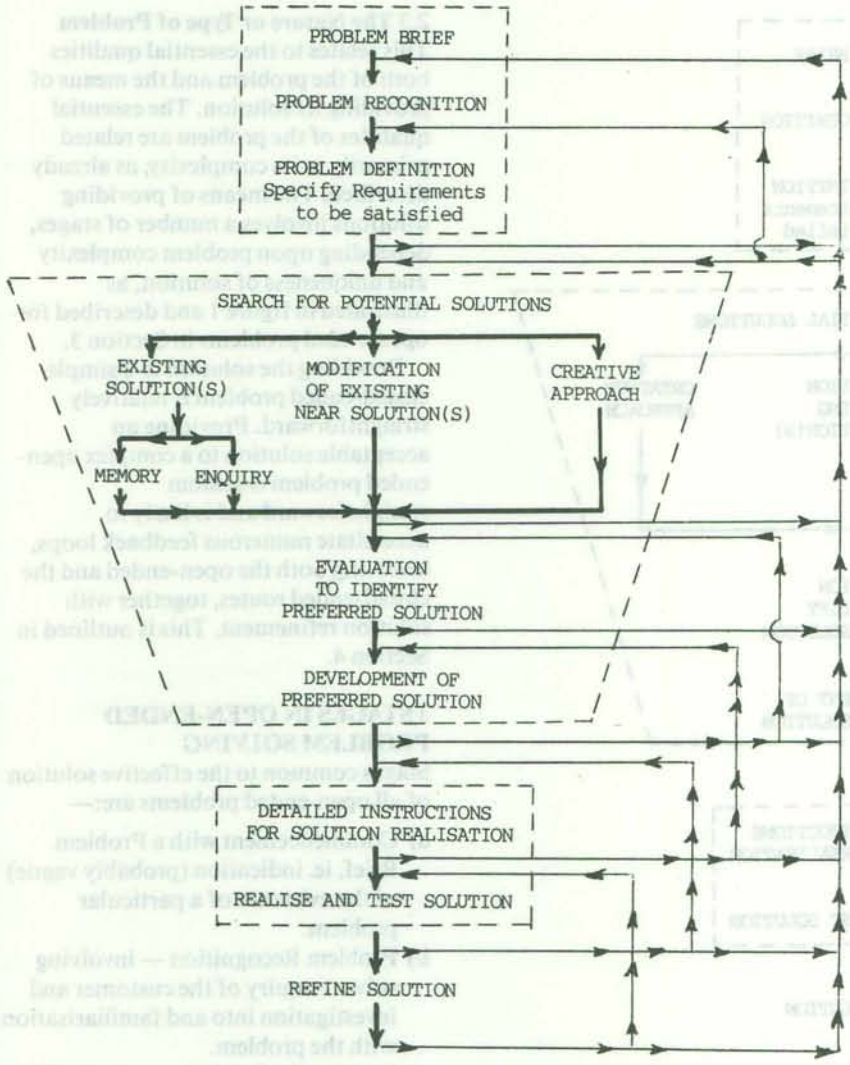

FIG. 3 AN OUTLINE ILLUSTRATION OF THE OPEN-ENDED PROBLEM SOLVING PROCESS SHOWING FEEDBACK LOOPS

g) Issuing of detailed instructions in appropriate form to relevant personnel for the realisation of the solution in a form acceptable to the customer. In Engineering, this would essentially involve the issuing of:
   * Technical drawings
   * Parts lists, and
   * Other approrpiate instructions — for the production of hardware.

The foregoing stages are presented graphically in figure 2 'A Simplified Outline Illustration of the Open-ended Problem Solving Process'.

Problem solving may well continue through the following stages:

h) Hardware realisation and testing of the solution.
i) Solution development or refinement — especially if:
   * the best possible solution is essential
   * the resulting 'product' is to be sold in a competitive market.

Open-ended problem solving will of course include the solving of some — perhaps many — closed-ended problems.

4. FEEDBACK LOOPS IN PROBLEM SOLVING

The solving of open-ended problems is unlikely to flow smoothly and continuously forwards as may be implied by the simplified outline illustrated in figure 2. As problem solution progresses, sub-problems will arise and imperfections will become apparent.

4.1 Sub-Problems

Complex problems in particular, although not exclusively, give rise to interactive open-ended and closed-ended sub-problems. This is implied at commencement of the Process as illustrated in figure 1.

4.2 Imperfections

As involvement with the solving of an open-ended problem proceeds, the problem solver is likely, with hindsight, to become aware of various imperfections, such as:

* his/her incomplete appreciation of some important aspects of the problem, or not having made the best decision — which can occur at any stage,
* inadequate awareness by the customer of the implications of the problem,
* other ideas that could lead to a 'better value' solution,
* the effects of changed circumstances, or
* etc.

The problem solver may immediately seek to make good such imperfections, or perhaps later produce a Mk2 solution, depending on the nature of the problem and upon such factors as significance of defect, time, finances and so on.

The action of returning to overcome imperfections is indicated in figure 3 by the presence of feedback loops.

5. DIVERGENT/CONVERGENT ACTIVITY/CONTROL

Four stages can be clearly identified in the undertaking of open-ended problem solving where the activities of the problem solver first diverge, then converge. They are:

a) Determination of the problem.
b) The search for potential solutions,

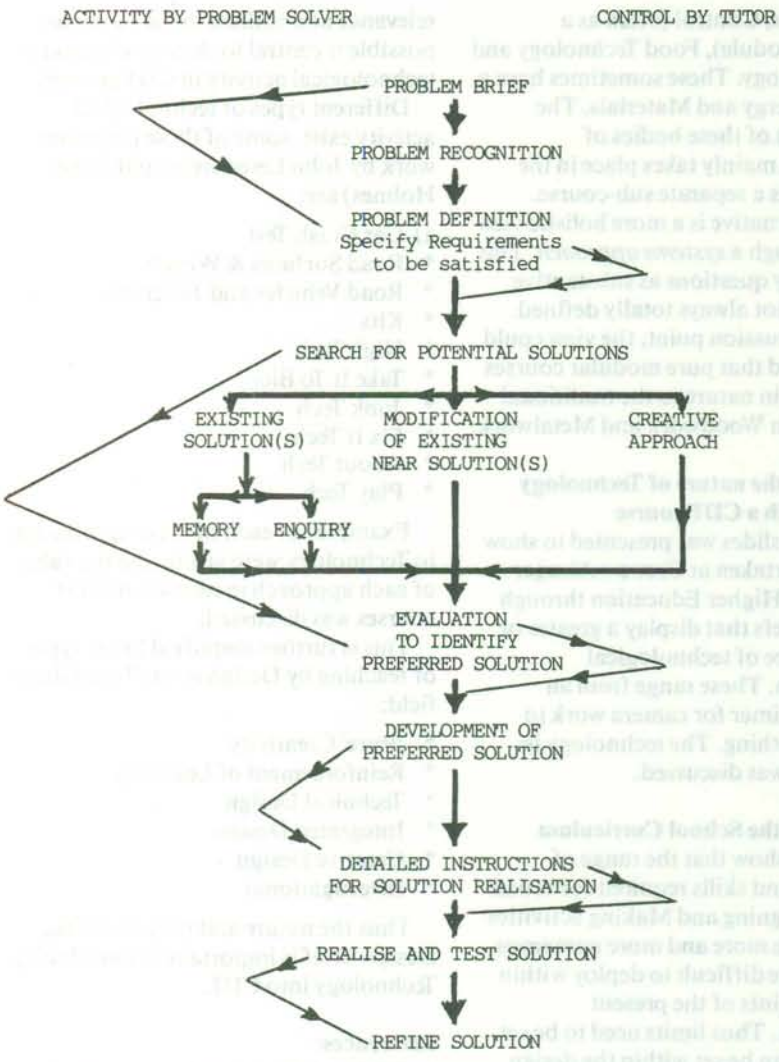

FIG. 4 A SIMPLIFIED OUTLINE ILLUSTRATION OF THE OPEN-ENDED PROBLEM SOLVING PROCESS SHOWING DIVERGENT/CONVERGENT ACTIVITY/CONTROL

followed by evaluation to identify the preferred solution.

c) Development and detailing of the preferred solution.
d) Realisation, testing and refinement of the solution.

For example, in determination of the problem, the problem solver will commence with a Problem Brief, then diverge his/her enquiries and actions in order to acquire adequate awareness of the essence and implications of the problem. Activities must then be converged in order to concisely formulate the parameters or requirements to be satisfied. Similar activity is applicable to each of the other three identified stages.

It is preferable that, if feasible, especially in a learning situation, problem solvers should work in small teams, for various reasons, eg.

* for stimulus
* to maintain momentum
* to share tasks
* to experience teamwork
* for interaction of different ideas, abilities and experiences.

If teamwork is not feasible, the tutor can compensate to some extent.

If several teams, or individuals, are working concurrently on the same problem, the tutor, at the end of each of the first three stages, can assess (if assessment is required) the contributions made to that stage by each team/individual. The tutor should then collate the collective contributions, including any personal additions that he/she may wish to make and present a comprehensive summary of the findings of that stage to all the problem solvers, in order to give them:

a) an improved understanding of and involvement with the problem,
b) a common starting point for the next stage,
c) improved motivation for the weaker problem solvers and minimisation of their weak responses becoming interactively accumulative.

This enables the tutor to exercise a controlling enhancement of the problem solving learning process.

6. CONCLUSION

Careful project selection and suitable tuition can enable a child to constructively develop problem solving abilities in order to:

a) be rewarded with greater enjoyment and value from CDT (or other appropriate subject),
b) help form a framework for successfully undertaking the open-ended problems of life and the world of work.