

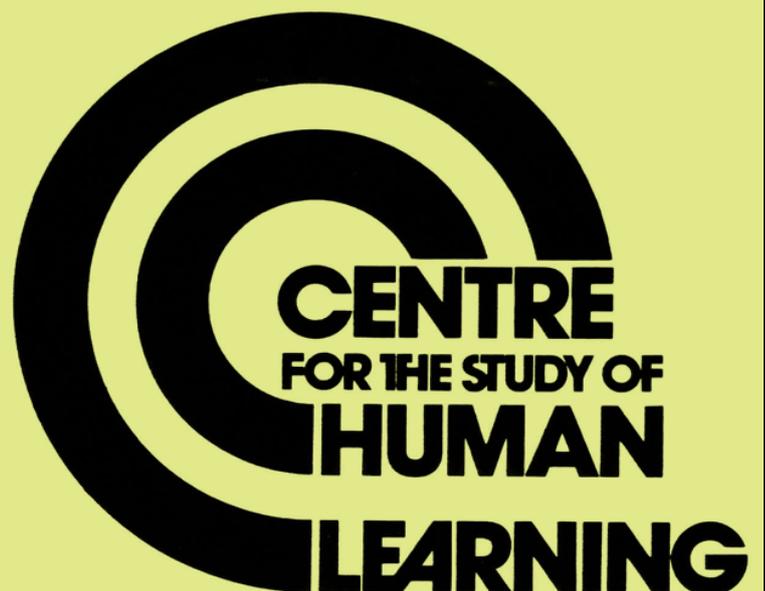
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Simulators Which Invite Users Into Learning Conversations

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The development of a range of new learning aids for complex computer-driven learning systems is described. An Air Intercept Control Skills Trainer is used to demonstrate the theory and technology of "Learning Conversations". This applies to the process of learning as well as to its content. The person-centred conversation paradigm of research accepts learners as active collaborators who are modelling, developing, reflecting upon and reviewing their learning skills. This requires freedom to structure activities, choose personal styles of execution and for evaluation of performance. The evidence reported demonstrates the emergence of a capacity for self-organised learning.

1. INTRODUCTION: THE NEED FOR A CONVERSATIONAL METHODOLOGY

A theory of learning must be concerned with how learners self-organise their own behaviour and experience to produce changes, which they themselves value. It requires techniques for making explicit the person's own constructions of the world, so that they may reflect upon them. The form given by George Kelly to his model of man as scientist has considerably influenced our approach (1). It is by its very nature content-free. It may be inhabited by any system of construction which would constitute "a person". The potency of Kelly's "construct system" is that it offers not only a theory but also the beginnings of an integral and systematic methodology. Together the theory and method contain an embryo of a new breed of aids for navigating the psyche. We have tried to develop this further into a more fully conversational technology. Our approach is concerned with developing aids which can represent personal experience and performance in ways which enable reflection, review and effective transformation of the quality of human learning. People can learn to distance themselves from the CONTENT of their own learning experiences and in achieving this, they are freed to explore and develop their learning competence. Conversational aids for talk-back are designed to achieve reconstruction of the learning events, which often cannot be fully experienced during the event itself.

The personal research process oscillates between structures of freedom, certainty and doubt. It depends on overcoming a universal tendency towards ultrastability and habitual content-bound modes of thought and feeling and behaviour (2).

2. ON CONSTRUCTING A LEARNING CONVERSATION

In any effective Learning Conversation, control is passed back and forth among participants as they recognise the nature of what each has to contribute. But all participants are not equal. Host conversations are asymmetric. In the early stages of the Learning Conversation the learners provide the evidence on which their collaborative research into the nature of their

learning is based. The manager of the conversation guides and controls it. As the learners' awareness of their own processes increase the manager hands over control of the awareness raising activities to them. He or she then begins to encourage them to challenge their personal myths about their own learning capacity. The learners are encouraged to change the emphasis of their attention. The Learning Conversation moves into the next phase. They begin to explore how the learning can be improved. The manager encourages them to explore alternative models of their own processes and to develop and test in action, personally acceptable theories about how they can learn more effectively. Gradually the manager hands over control of this exploratory activity to the learners until eventually only the quality of the learners' personal investigation remains under the manager's review. The total conversation is phased to enable the learners to obtain insights which allow them to conduct more and more of the conversation for themselves. The ability to conduct most of a learning conversation with oneself is the essence of 'self-organisation'.

The process of a conversation can be distinguished and described separately from its content. The conditions for creative conversations require that an exchange is modulated through a shared understanding of how the conversation will be conducted and that this model of the process itself remain negotiable. Such conversation is rare. People may achieve such creative conversation within themselves. This is the core of self-organised learning. Our challenge has been to explore how a GAL system can facilitate this.

To be truly conversational, the technology of learning must allow relevance and viability to be assessed by the learner.

The criteria and referents used by the learner may be challenged and renegotiated but they cannot be ignored, denied or arbitrarily over-ridden by other perspectives without destroying the sources of self-confidence and self-sustaining growth. The Learning Conversation encourages and enables the growth of this capacity for self-organisation. Choice of specific techniques i.e. conversational aids to be recruited into the Learning Conversation depends upon the nature of the application. Learning skills, learning situations and topics to be learned may all require special techniques for awareness-raising. The conversational learning aids used in conjunction with the AIC Skills Trainer (footnote at end of Paper) represent some selected examples, here reported.

3. THE LEARNING AIDS REPRESENTED IN THE SKILLS TRAINER

There are four categories of basic learning aids available to the user of the simulator. Together they are recruited to support Learning Conversations. These basic aids allow the learner and instructor to specify and file learning situations relating to the task and starting conditions for executing the task. Various forms of feedback are available during the run. Records of performance allow TALKBACK and experiential RECONSTRUCTION of the process of learning and records of expert performance can be as demonstrations and as referents against which to evaluate learner performance. In details these facilities are categorised as follows:

i) Learning Tasks

The scenario and file facility offers an opportunity to define starting conditions and the type of intercept or safety conditions to be practised or both. It allows one learner to do a series of trials from the same situation or it allows learners to compare their performance against each other, and it allows one or more expert solutions to be generated and filed from the same

starting conditions as the learner is faced with. It also offers the learners an opportunity for systematically developing their skills in initiating starting conditions, task definitions and learning purposes, and to pose them learning experiences of increasing difficulty which systematically span the given range of experience.

ii) Feedback During the Run

Backtracks - normally the radar echo disappears after one or two sweeps. but this facility retains the echoes tracing out the path of the aircraft. This provides a valuable aid to perceptual learning. Varitime - allows the learner to slow down or speed up the run to enhance awareness of performance in terms of judgement and timing. Arc - defines the weapon acquisition area within which the fighter must be guided to make a kill. Again this is a valuable aid to enhance perceptual training. Circles - provide a visual signal if a fighter gets dangerously near to stranger. Stop and Continue - together offer the learner an opportunity to pause and reflect during the run. During such a pause all the facilities under category three are available for assisting the learner to reflect on and review the learning process. In general all these run time facilities highlight the consequences of the learners' commands thus increasing their understanding of the system of causes and consequences embedded in the task.

iii) Records of Performance

The file allows the learners or instructor to store demonstration runs and allows the learners to replay and take themselves back through their performance, reconstructing the experience and thus raising their awareness. This provides data for feedback in the process dialogue of the Learning Conversation. This talkback enables the learners to reconstruct the decision making which produced the performance and thus the strategy which they were using. Replay reruns the performance at whatever speed set by Varitime. Performances may be overlaid for comparisons. Thus the learners can compare themselves with the expert or with their own performances over a number of runs using the same scenario. Similarly peer learners can compare each others' performances. Print Picture coupled with the Stop facility allows the learners to photograph the screen at any point. Again this can be used as a valuable aid to perceptual learning. Trackdata provides a complete protocol of a run starting from the scenario conditions and recording the nature and time of every instruction to fighter, target or strangers. In addition it separates the instructions to each aircraft and prints a chronological record of the instructions to each record separately. By mapping Trackdata onto the Print Picture or by 'reading' the Print Picture, the trainees can learn to mentally connect the commands given to the visual representation. This offers a powerful tool for grouping commands into patterns, thus building up a perceptual language for visual representation.

iv) Expert-Performance

In addition to the records of expert performance provided by having an expert perform a run, the simulator is able to provide its own computer generated expert solution. These are computed on the basis of a simple 3 turn mathematical optimisation and can be shown via the Solve (immediate display), or Fly Yours and Fly Mine (real time displays) commands. Expert performance and computer solutions offer a tool for enhancing the Learning Conversation. They provide process measures of performance. By exhibiting the process by which expert results are achieved they offer a much richer opportunity for comparison and assessment.

4. BECOMING AN EXPERT: THE LEARNING CONVERSATION

Once learners are sufficiently familiar with the Skills Trainer they can begin to use it as a real aid to their own learning; the conversational procedures begin to encourage them to make this very process more explicit (3).

The Personal Learning Task Analysis (P.L.T.A.) enable trainees to define and pursue their own learning purposes in relation to the task and to recognise these as separable from the instructors' or experts' definition of the task both in terms of the sequence in which a given sub-task should be learnt and of the instructor's own interpretation of the kinds of problems which the trainees are likely to experience.

This is an essential step in guiding the trainees to learn to take greater responsibility for their own learning.

4.1 Negotiating a Personal Learning Contract

The P.L.T.A. procedure encourages learners to: i) define their own purposes; ii) plan their strategy by which these may be achieved; iii) generate criteria by which they can judge the quality of their outcome; iv) review the whole learning process to discover how best to define their purposes more appropriately; -invent alternate strategies for optimising the ways they achieve their self-chosen purposes; -generate more precise criteria for judging their outcomes. They are thus enabled to control their learning in personally relevant significant and viable ways. As this Learning Conversation clarifies issues involved in negotiating and pursuing a Personal Learning Contract, the trainees are encouraged to identify how they will use the learning aids built into the machine to: i) define one or more scenarios best suited to their learning purposes; ii) to use feedback devices for reflective learning during the run; iii) to use records and playback devices in a self-debrief.

This phase of the Learning Conversation is also designed to enable learners to begin to see their learning within a time structure.

4.2 Taking Action in the P.L.T.A.

Having considered their plan of 'what' and 'how' they going to learn and then having put this plan into action, the trainees attempt to monitor their learning as they are engaged in the self-defined exercise to do with one specific aspect of the task. It is here that the STOP facility available at any time during the RUN allows them to freeze this action, thus giving them space and time to reflect on their own processes, without interfering with the execution of the run. This reflective process allows them to reconstruct the immediate experience and to become conscious of what they are doing. The REPLAY facility in effect allows them to relive the same experience using their new insights to improve their performance. It is this opportunity to relive and personally observe this experience a number of times in a series of immediate mini self-debriefs' which encourages the development of a 'personal internal observer'. Eventually this observer is able to provide a meta-commentary on the primary process without interfering with it.

The STOP facility also focuses the learners' attention on the timing and structure of their skill as this plays out in their performance.

The P.L.T.A. procedure offers a heuristic for negotiating, identifying and carrying out Learning Contracts of different sizes or levels of complexity of learning activity. All the perceptually enhancing learning aids are available during each pause and also at sequences of pauses and at the end of a RUN. The learners can begin to see a continuously developing hierarchy of sub-contracts, contracts and superordinate contracts, during the process of learning. (Fig. 1). PRINT PICTURES taken during a series of pauses in a run, not only provide a visual feedback about each sub-contract, but they also build up into a sequential record of the process by which the whole contract was achieved.

At the end of ACTION or RUN phase of the Personal Learning Contract, the conversational procedures encourage the learners to reconstruct the whole learning experience to reflect on it. All the learning aids available during the STOP facility are also available on completion giving the learner an opportunity to relive, observe and reflect upon the structures of their behaviour and experience the learning process over a longer time span.

Trainees have very underdeveloped capacity to remember the precise nature and sequence of events and to reconstruct sensitively and accurately the experience associated with these events. The RECORDS of performance, i.e. FILES, KEPLAYS, PRINT PICTURE AND PRINT TRACK DATA provide an objective referent against which events can be recalled more accurately and the experience more validly reconstructed.

The P.L.T.A. technique is designed to progressively lead the learners into an ever increasing awareness of their own learning processes. This is achieved by negotiating and carrying out learning contracts within which sub-contracts are increasingly well articulated. The learners are also aided to gradually recognise the part that the pre-specified learning contract plays in their longer term learning activities.

As shall be seen later from the results of these conversational studies this process of representing learning within a hierarchy of learning contracts each of which has its own PSOK Structure allows learners at any level of achievement and competence to get to grips with their performance at just that level that conscious attention can make the greatest personal impact. This challenges existing understanding and skill in the task so that they can thrust forwards towards creating new levels of competence. The conversational learning aids which form part of the P.L.T.A. as well as the basic learning aids already addressed by the Skills Trainer are designed to achieve this awareness and self-organisation of learning.

5. THE CONVERSATIONAL RESULTS

5.1 Case 1. A Naive Learner

Initially Jack had great difficulty in identifying and defining his own learning purposes and he tended to be rather haphazard and random in his activities. Using the P.L.T.A. procedures in conjunction with the aids addressed by the machine, he began to formulate clearer and more relevant purposes.

After the third session Jack began to formulate contracts with much shorter time spans and more precise purposes. The execution of these yielded results which he was encouraged to explore with the REPLAY and PRINT PICTURE facilities. From this he began to define the task in a much clearer and more realistic way which in turn gave him the criteria for generating his next purpose. As he learnt to control the movement of the aircraft around the

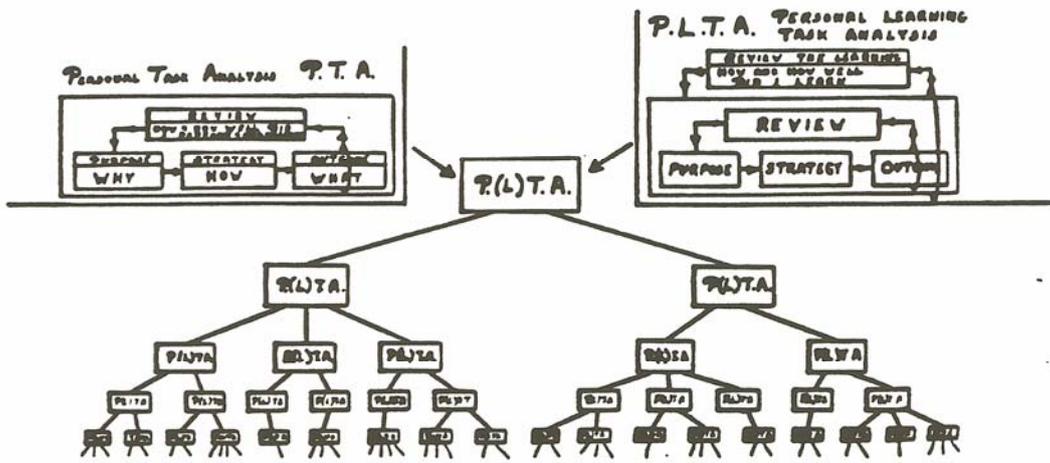


Fig.1 The Hierarchical Structure of P.L.T.A. and The Structure of Each Mode in the Hierarchy.

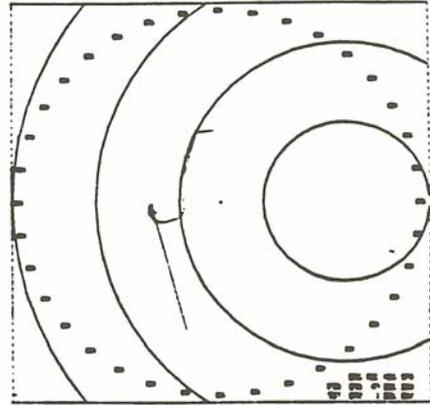
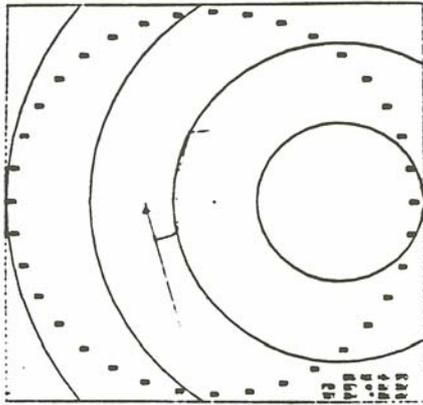
screen he began to attempt intercepts, but with very little success. He intensified his P.L.T.A. activities and began to explore the idea of strategy in greater detail and to define exactly how he planned what he was going to do. This led him to realise that he had no clear idea of what an intercept was in terms of the instructions which could be given to the fighter to control its position relative to the target. To explore this intensively he worked on the dynamic grid facility. The autopilot aid demonstrated the difference between an A1, A2, A3, and A4 intercepts, which intrigued him and he began to seriously tryout his skill in completing 90 degree intercepts. In fairly rapidly moving from being wildly out in both displacement and the point at which he started his final turn he rapidly came to achieve three good intercepts consecutively. However as soon as he changed the direction of the target, this newly acquired skill disintegrated.

For the first time he became animated and started to really try to explore the dynamic relationships between direction and position of the target and positioning of the fighter to make the final turn. In his self-debrief he revealed that for the first time he could control his own learning and it became clear that he had experienced a perceptual reorganisation of the task. Whilst originally he had been seeing the target and fighter in terms of their absolute positions on the screen (which explains why a change in the direction of the target led to a disintegration of the skill), he soon came to see fighter and target in a pattern relative to each other. He realised that this pattern persists irrespective of their absolute positions. Having identified this pattern for himself he was able to set himself a series of learning contracts which enabled him to explore and consolidate his understanding of the dynamic geometry of a 90 degree intercept, Figs. 2 & 3 illustrate this.

This was a turning point in Jack's learning. He was able to put his two new skills together in a series of successful intercepts. He went back to the grids and learned the dynamic geometry of the A1 (180 degree), A3 (120 degree) and A4 (150 degree) intercept types and did a series of intercept sorties in which he specified both type of intercept and where this would take place.

5.2. Case Study 2. Skilled Practitioners: Two Officers with Falklands Experience.

Towards the end of the first day they were familiar enough with the Skills trainer to be setting up their own scenarios and carrying out their own sorties. They also formulated their first Personal Learning Contract, although this was defined and achieved entirely in task-bound terms. On the second day they quickly developed a routine of creating their own Personal Learning Contracts and working these out with the Skills Trainer, gradually familiarising themselves with the learning aids although at this stage these were again seen entirely as task aids. On the third day they set up a whole series of Falklands scenarios and began to exchange experience by both in turn trying out the same task from the same scenario. Towards the end of this day they began for the first time to formulate learning purposes which, while still completely in terms of the task, were specifically related in improving their tactics rather than executing complete and perfect sorties. This was the first sign that they were beginning to understand the difference between a Task contract (P.T.A.) and a Learning contract (P.L.T.A.). On the fourth day both officers explored quite personal issues of skill. They worked privately. They made extensive use of all learning aids. They reported going through a very anxious period whilst their usually high level of calm and skill appeared to have deserted them. They were enabled to work their way through this and expressed considerable satisfaction at the insight they had gained into the emotional dynamics behind their tactics. On the last day the officers developed a whole series of



Figs. 2 & 3 Exploring the Dynamic Geometry of a 90 Degree Intercept

detailed suggestions for how the skills trainer could be modified and elaborated for use as a learning aid at sea.

This in depth conversational study with two experienced fighter controllers highlighted the potential of the Skills Trainer as a practise and planning device for the expert. It also proved to be an effective conversational vehicle for enabling two skilled controllers to converse and exchange experience operationally with a depth and precision they could not achieve verbally. They would be unlikely to find a real (operational or training) situation where such conversation could take place.

Again the study showed the need for methods of generating effective Learning Conversations if the potential of the Skills Trainer as a learning aid is to be exploited.

It took Paul and James three intensive days to recognise the difference between task bound and task free learning contracts i.e. between task practise and self-organised learning activities.

Their assessment was that a computer aided learning device such as the Skills Trainer, in a form more fully addressing the practise of Learning Conversations as embodied by the P.L.T.A. procedures could make a significant contribution to improving the quality of learning "on the job" at sea.

5.3 Case Study of Three Officer Trainees.

Each trainee used the Skills Trainer intensively with at least some of its Learning Aids. They worked together on it in their own private study time and they helped each other to solve specific learning difficulties. Each trainee used the STOP and CONTINUE facility to create 'mental space' to think, reflect and re-plan. Each used VARITIME, largely to quickly locate the critical event, which demanded some reflection. Each tried the COMPUTER SOLUTIONS but found these on the whole unhelpful. Each had used the PRINT PICTURE sequences as aids for their P.L.T.A. activities.

Their major learning experiences included: i) I moved from the tunnel vision to more global, but I still have a long way to go. ii) One can't 'pigeon-hole purposes, I need to integrate these into a plan of action. iii) Stop in order to Reflect enables advances to be made in different directions. iv) Very useful to have to write down personal responses or/and explain to someone else. v) I learnt to diagnose my own problems and to set specific tasks relating to these, and to set up appropriate scenarios. - Up to now my instructor diagnosed problems for me, and these I feel are not always right for me. vi) I learnt to become more aware of the whole picture, to identify a wider range of variables in the whole task. vii) I learnt to imagine patterns on the screen and to understand the PROCESS of pattern construction. viii) I realised the need to plan ahead, so as to achieve specific intercepts, particularly with Bravos and Charlies 4's. ix) I learnt to improve planning of a whole SORTIE and to achieve most of my aims or to flexibly adapt these according to changing circumstances. x) I learnt to use the P.L.T.A. Heuristic for getting to know 'more about me as a learner' and I learnt how to achieve greater awareness of my own learning style.

One outstanding finding in this case study was the ease and enthusiasm with which all the trainees carried out their personal experiments, once they had understood the task involved and how they could use the machine as a learning device.

It has not been possible to build specific formal evaluation measures into the study, but some findings are useful indicators of effectiveness. The instructor who was responsible for the whole training course during this study informally rank ordered the trainees at the beginning. One was border-line in terms of predictions of final success. In rank ordering them towards the end, this trainee was ranked as first and very likely to succeed. Interestingly, this trainee had spent most time on the Skills Trainer and had used its learning aids intensively and set himself many learning contracts through the P.L.T.A. activities. A consistent feature within his learning contracts was that of 'pattern making' and 'anticipation exercises'.

In comparison with other trainees on earlier courses, who had also worked on the Skills Trainer, but without the conversational P.L.T.A. procedures the trainees could debrief themselves much more fluently and the quality of these events were significantly better both in terms of process and in terms of task performance. In all three case studies it became clear that in the absence of the P.L.T.A. procedures the Skills Trainer was used largely as a Practise and not as a Learning Device.

In learning a task a person is building up a model of the operating situation in his head and is gradually developing an understanding of 'what goes with what', i.e. of the causal relationships in the system. This model of the causes and consequences develops usually in an unconscious and unreviewed way, but is very complex and subtle, being a system of detailed perceptual motor relationships underlying the learner's ability to anticipate and control the situation. The learning aids addressed by the machine and the conversational P.L.T.A. aids opened up a new level of understanding about individual processes of learning.

These conversational results substantiate our functional framework for Self-Organised Learning. They have implications for developing a taxonomy of CAL-based conversational learning aids. (Table 1). These can be recruited to form a "Learning Shell" for a computer based system.

6. AWARENESS AND THE LEARNING CONVERSATION

In looking at the process by which someone learns a task it is possible to identify three stages in moving from the unconscious doing of the task (i.e. the task robot) to fully self-organised learning. i) In the first stage of learning the person does the task by dogged practise and repetition with an often implicit tactic of 'trial and error', they acquire some level of competence. Many years of such practise leads to the skilled technician. But he is totally content or task-bound. ii) In the second stage of learning the person stands back, observes and reflects upon the implications of their practise. Thus, raising the blind trial and error method into a more rational and coherent approach to the process of doing the task. But, at this stage in the development of learning the task is still the total focus of attention.

Awareness is concentrated on observing the process of doing the task and using the results of these observations to systematically experiment and improve one's performance. iii) At the third stage of learning, the focus of attention shifts. At certain intervals in acting out stages I and 2 the person stands back one a further step, to take stock not only of how one is doing the task, but also to reflect upon the process of learning itself. It is this second phase of awareness which is the crucial trigger to total self-organisation in learning. It is this which proved so difficult (or impossible) for some of the subjects of our study, without the aid of the Personal tutorial Learning Conversations. In stage one there is no awareness of process and therefore no possibility of conversation about learning the task. Many of our subjects found that being lead into systematic observations of themselves doing the task (stage 2) was

TABLE 1. Aids to Self-Organised Learning
(i.e. The Learning Conversation)

KEY - n Aids addressed by the Skills Trainer
 φ Aids addressed by the P.L.T.A. Procedures

- A. Aids to Learning the Task: Task Focused Conversational Learning Aids
- n 1. Aids that Enhance Feedback about Task Performance.
 - φ 2. Aids for Eliciting and Representing Personal Knowledge about the Task.
 - φ 3. Aids for Task Definition, i.e. Topic and Purpose.
 - n 4. Aids for Building a Bank of Records of Performance.
 - mφ 5. Aids for Comparison of Performances.
 - φ 6. Aids for Identifying Criteria of Success.
 - φ 7. Aids for Reflecting on Performance.
 - φ 8. Aids for Reflecting on Knowledge and Experience.
 - φ 9. Aids for Challenging Personal Myths about the Task.
 - φ 10. Aids for Comparison of Learner's Knowledge with Learner's Performance.
- B. Aids to Enhance the Capacity to Learn: Learning Focused Conversational Aids
- φ 1. Conversational Machine Familiarisation Procedures.
 - φ 2. The Learning Conversation - Phase 1.
 - 2(i) The Personal Learning Contract and the Personal Learning Task Analysis Procedure (P.L.T.A.).
 - 2(ii) The Double Debrief (i.e. the task debrief and the learning debrief (P.S.O.R. Procedures)).
 - 3. The Learning Conversation - Phase 2
 - 3(i) Review of P.L.T.A. Contracts.
 - 4. The Needs and Relevance Conversation.
 - 4(i) Pegasus and other Reflective Repertory Grid Technology.
 - 5. The Learning-to-Learn Conversation.
 - 5(i) Talkback of Behavioural Records and Personally Elicited Models of Experience.

a significant insight. This allowed them to change learning a task from a ritualistic, determined and sustained use of practise with occasional haphazard insights, into systematic learning activity. The proper use of the learning aids in the Skills Trainer provided a mechanism for articulating these systematic insights. We term this the content-focused or task-focused conversation. A Learning process-focused conversation arises in moving from stage 2 to stage 3 where the process of learning is the new content or 'task' focus for the conversation. Fig.4 illustrates these stages.

Thus the Task Debriefs used in many conventional RN Skills training courses can be seen as falling into stages 1 and 2. What is missing is the construction of a Learning Debrief which can elevate the conversation into Stage 3. This is the essence of what we call the Learning Conversation. The Personal Task Analysis procedure (P.T.A.) can be used for systematising the conversations about learning the task (stage 2) whereas the Personal Learning Task Analysis (P.L.T.A.) is the procedure for facilitating the whole Learning Conversation (stage 3).

7. TOWARDS A CONVERSATIONAL CAL-SIMULATOR

As has been seen, the mere existence of the learning aids built into the machine does not ensure that they will be used either effectively or at all. Learners need sufficient understanding of their own processes to be able to recruit the learning aids into their personal learning processes. This is what Self-Organised Learners can do. The trainee who sets out to become a Self-organised Learner is developing an entirely different cognitive model of the task and of himself as a learner. He uses the learning aids in the machine for reflection upon how he performs the task (i.e. stage 2 task-focused conversation) and tests out within a Self Debrief of the task, whether he has performed well, according to the agreed standards of performance. When available he also compares his achievements against peers or/and a number of different experts performances on the task, to evaluate his own skills. This learner can relate the trainer diagnosis of his performance to his own diagnoses. But the skilled Self-organised Learner can do more than this. He can define learning in relation to his own previous performances and develop precise criteria of his own for the ways in which he is learning the task. He is in a position to ask himself not only whether the task can be done better but also can he learn in a better way.

The Self-Organised Learner is able to conduct two phases of awareness-raising conversations. At one phase (i.e. stage 2, Fig.4) the task itself is the primary focus of attention, everything acquires meaning in terms of whether the Skills Trainer and its aids assist in performing the task well. At the other phase (i.e. stage 3, Fig.4) the process of acquisition of skill, knowledge, attitude, etc. is the focus of attention. Everything acquires meaning in terms of whether the Skills Trainer and its aids offer greater awareness of the personal processes of learning, and thus greater self-control of these.

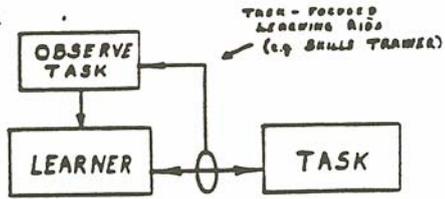
The cognitive modelling capacity and hence the learning capacity of those trainees who learn to use the CAL device for reflective learning in both phases 1 and 2 modes develop their own sophisticated internal feedback generating mechanisms about their experiences, and relate these to external feedback or 'knowledge of results' obtained about their own behaviour or performance. These then are the flexible, adaptive learners who have the potential to develop into the real experts in training others to develop equally high standards of expertise.

STAGE 1



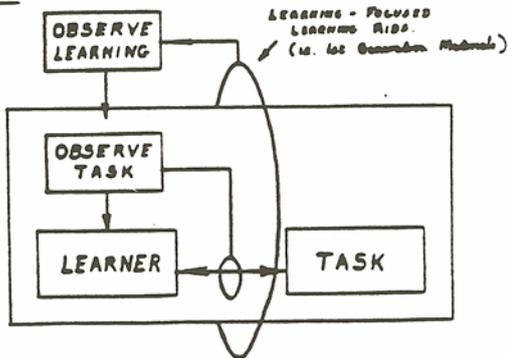
TASK-BOUND: NO CONVERSATION
(NO AWARENESS OF LEARNING)

STAGE 2



TASK-FOCUSED CONVERSATION
(AWARENESS OF "LEARNING-THE-TASK")

STAGE 3



LEARNING-FOCUSED CONVERSATION
(AWARENESS OF THE PROCESS OF LEARNING)

The conversational methods used in the case studies, revealed the processes of human behaviour and experience at work on 'real' tasks. The raw results appeared at first sight to be episodic and unrepeatable but once an appropriate conversational model is used to systematise and organise them they immediately became coherent.

The P.L.T.A. conversational procedures were designed as stepping stones towards such a model which the learner can come to use to explain and thus predict and control his own learning processes.

8. TOWARDS SPECIFICATIONS FOR AN 'INTELLIGENT', FULLY CONVERSATIONAL COMPUTER-AIDED-LEARNING SIMULATOR.

Our basic argument is that a conversational CAL simulator must address the following issues: i) the representation of behaviour or performance must be complemented by a facility for addressing representations of knowledge and experience. ii) The performance records must be capable of hierarchical analysis, e.g. in a form analogous to the Print Picture/Print T Data syntax discussed in the Case Studies. Timing and other indications of display-control discontinuities can be used to parse the performance. iii) The model of performance analysis and the representational forms of task knowledge and experience must be compatible one with the other, allowing a matching between how a person performs the task and how they consciously understand what they do. iv) One or more records of expert knowledge and performance serves as a referent against which the knowledge and performance of the learner may be evaluated and an analysis of this comparison can be used to identify a tutoring strategy by which the learner can be led step by step into the experts' expertise. v) The idea of a Personal Learning contract allows the learner freedom to define the task in their own way, and to identify their own methods and understanding of how the task may be done. vi) The Personal Learning Contract also allows the learner to reflect on the personal process of learning. It is this which transforms the capacity to learn.

This involves the need for a second level of representation in the CAL device, shown as Stage 3 in Fig. 4 where the P.L.T.A. embodies both performance and knowledge representations of the activity of learning, addressed separately from the process of doing the task. vii) Finally, within the Learning Conversation, the learner is helped to become aware of the process of managing Self-Organised Learning so that they learn to take this over for themselves and become more fully self-organised. Fig.4 and 5 illustrate this.

In education and training the development of computer-aided learning systems has enormous potential for promoting self-organised learning. A wide range of tasks and skills from Appraisal, Recruitment, Management Skills, Quality Control, Training of Trainers, Course Design and Evaluation, Reading and Communication Skills, Decision Making, Skilled Performance of Highly Complex Tasks and Creativity can all be systemised within a technology for Reflective Learning. Individual groups and whole organisations can be so enabled to function as effective learning systems.

Footnote: The Air Intercept Control Skills Trainer was developed at the Applied Psychology Unit of the Admiralty Marine Technology Establishment in 1980. SCICON Int. Ltd. were the programming contractors and the Centre for the Study of Human Learning acted as consultants on Task Analysis and Learning Aids.

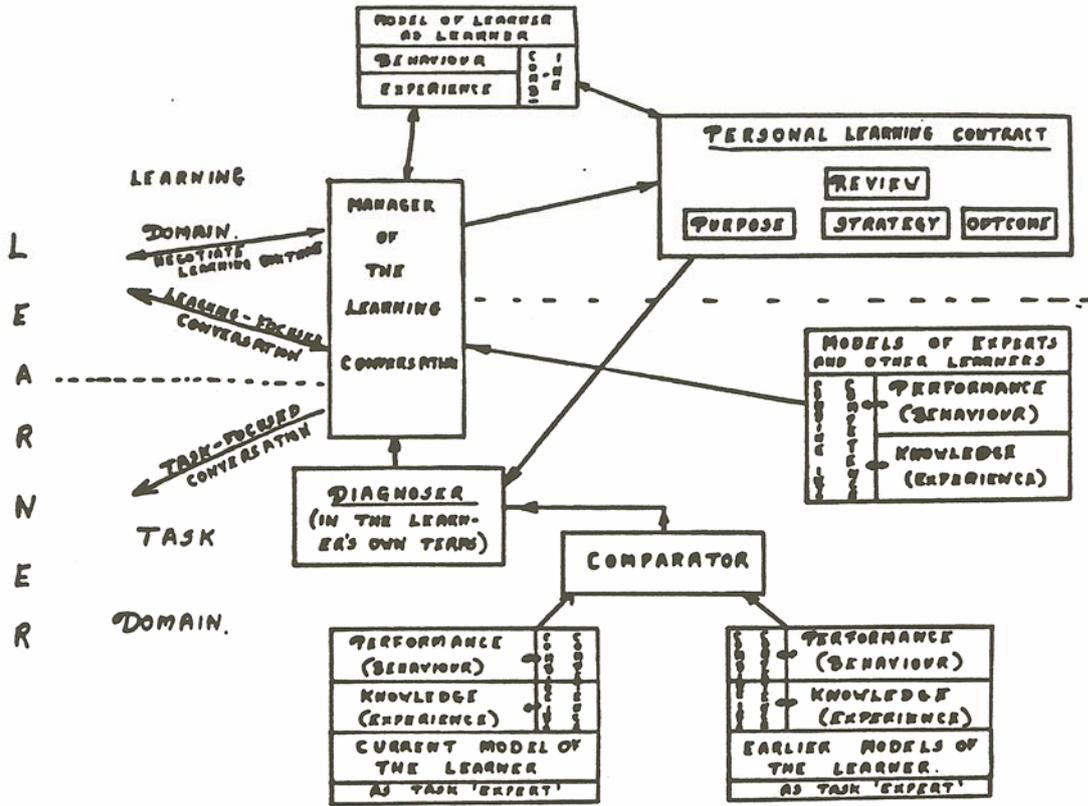


Fig.5 Outline of Computer-Aided Learning, Based on Learning Conversations

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