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INTEGRATED TRAINING SYSTEM FOR AN
AERONAUTICAL TRAINING CENTRE

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Because of the increasing complexity of the helicopter's systems (on-board computer, instruments, commands, audio devices, etc.) there is an increasing need in highly qualified and constantly up-to-date personnel. These reasons lead to increasing costs, but modern computer science helps us providing appropriate tools capable of reducing expenses and time required for training. This paper describes the Integrated Training System developed by Agusta Sistemi in terms of trainers and methodologies applied in using training systems.

INTRODUCTION

There is an old chinese proverb that says:

"If you tell me, I forget;
if you show me, I remember;
if you let me do, I understand."

Applying this concept, the goal of a training system is to let the students do in order to train, improve and maintain the skills of operational crew members (flying crew and mission system operators) and maintenance technicians. Within each category, there is a number of different systems that enable the trainee to progress from the classroom to the real system.

Agusta Sistemi has applied the concept of Integrated Training System, not only in terms of complementary training systems, but also as training methodology; the new training method allows to minimize the cost-effectiveness ratio and offer better safety standards. Tab. 1 shows the differences between traditional and innovative learning.

Furthemore, the possibility to introduce artificial intelligence techniques will allow to create devoted expert systems capable to improve the evaluation of student performances and knowledges during training sessions.

NEW TECHNOLOGY FOR TRAINING: COST/EFFECTIVENESS CONSIDERATIONS

Talking about training in operating centres and for industrial application, it is out of discussion that "..... every reduction of time required for training is an increase of time that the personnel can dedicate to operating activities" [1].

It is then reasonable to consider that new training technology can be recommended for adoption when:

- a) it is more effective than current technology and costs the same or less;
- b) it has about the same effectiveness but costs less than current technology.

Tab. 2 shows in a schematic way these criteria, also enhancing uncertain situations for what the criterion could be: "...Where there is no significant difference both in effectiveness and cost, the appropriate decision is to do nothing..." [1].

SIMULATORS AND TRAINERS

Simulators and trainers are not exactly the same types of systems. They have usually different purposes and could be designed with different criteria.

The main goal for simulator design is to reach high fidelity in representation of real world cues. The main goal for trainer design is to incorporate the behavioural understanding of how learning takes place within a trainee.

The following definitions can be given [2]:

Simulator: a machine that must reproduce as more as possible the real phenomena likely they occur in the real world. Engineering and research simulators represent and manipulate real world phenomena so that conclusions may be reached about man-made products such as aircraft.

Trainer: a machine which presents to the trainee only the necessary training stimuli, feedback, reinforcement, remediation and practice opportunities appropriate to the trainee's learning level and style.

A simulator can be then utilized to supply appropriate training opportunities to already skilled students, but can not be utilized as a help for an instructor to transfer such skillness to a student.

In aeronautical field application, for instance, a simulator, as it has been defined, can be very useful to help an expert pilot to improve his capacities in particularly dangerous manoeuvres, but it is not useful as training tool.

All these problems lead then to the Gagne's [3] sentence: "..... In many instances, the discrimination between what is essential or unessential for the representation of a critical skill requires no great amount of technical (engineering) knowledge..... When a need for a training device is developed, this in itself implies the

belief that certain essential skills can be more simply represented than by means of a replication of the operational situation....".

INTEGRATED TRAINING SYSTEM: METHODOLOGY

Before choosing an appropriate training system, it is essential to identify the training requirements and training phases to follow to reach the goals.

Usually the student proficiency can be broken down in three phases:

Understanding: the student meets the basic subjects relevant to right task.

Retention: the student must be able to discriminate between more and less important events, manage the system with appropriate actions and familiarize with learnt procedures and cues coming from the external environment.

Automation: this phase completes the training and must be characterized by the capability of the student to recognize the information and have the right reaction in the right delay of time.

The Fitt's diagram (Fig. 1) shows the three phases also giving indications about what type of training systems offers the better cost/effectiveness ratio.

When the phases are identified, training has to be correctly programmed, in consideration of available personnel skill level. The training process and knowledge evaluation (Fig. 2) should then take into account:

- profile/category of personnel to be trained;
- training methodologies for each training phase recognized as applicable (basic/conversion/operative/recursive training);
- definition, design and implementation of courses;
- definition of training aids and systems for each training phase and for each course;
- programmes for student knowledge evaluation;
- courses validation.

On this base a methodology for the training procedure must be defined (Fig. 3).

As a consequence of the shown schemes, the training design shall be:

- a) modular, to allow an easy develop and check of the training system;
- b) flexible, to be capable of being modelled on real user needs and then follow natural evolution of training requirements.

At last, the design and develop of training systems will be based on:

- a) define the design pathway;
- b) organizing information on the operational system;
- c) analysis of tasks involving human participation and definition of a training priority list (that is, the training system will have to choose some actions instead of others);
- d) gross device definitions;
- e) characteristics of the operational environment to simulate for training;
- f) detailed design.

If these phases are not considered, the design could not define training systems but traditional simulators as there is no possibility to transfer new information and knowledge to the trainees.

INTEGRATED TRAINING SYSTEM: THE TRAINERS

The previous methodology leads to the definition of the training aids able to satisfy the different training sessions. These systems are related one to each other as shown, for example, in Fig. 4 for a typical helicopter training centre.

COMPUTER BASED TRAINER (CBT)

As regards to the Understanding phase, a Computer Based Trainer (CBT) is a useful mean for the student in order to better learn in a shorter time with respect to the traditional classroom methods (as shown in Fig. 5). This brings to a higher "course productivity" and lower costs, increasing the cost/effectiveness ratio.

In particular their effectiveness depends upon the following characteristics:

- a) unique, constant and objective training quality standard;
- b) course personalization: each student schedules his training (time required) upon his own rate of achievement;

- c) grant of a continuous learning;
- d) training strategies closely related to each student depending on his own background;
- e) instructor full availability for each student and therefore increase of instructor effectiveness and role quality.

These systems may operate utilizing high quality graphics, real images (videodisk device) and audio device to fully involve the student during the training. This creates permanent mnemonic knowledge stimulating his imagination. In fact, recent statistical studies confirm that "..... a human being remembers the 20% of what he/she hears, the 55% of what he/she sees and the 87% of what he/she simultaneously sees and hears....." [4]; moreover "..... with respect to the past, after three days, he/she remembers the 10% of what he/she has heard, the 20% of what he/she has seen and the 75% of what he/she has simultaneously heard and seen....." [4].

PROCEDURES TRAINERS

The Procedures Trainers allow the retention training phase. The student learns one by one the critical procedures in order to optimize the automation training phase that will take place on the flight and/or maintenance simulators. This leads to a cost reduction due to a higher availability of the simulators.

Part Task Trainer (PTT): system devoted to the training on specific aircraft system (for example: on-board computer, visionics, armaments, functional mock-up, etc).

Cockpit Familiarization Trainer (CFT): real dimensional cockpit where each student can familiarize with the layout of instruments, commands, etc..

Cockpit Procedure Trainer (CPT): real dimensional cockpit with software simulated instruments and, in case, simplified motion and visual system in order to familiarize the student with critical flight procedures.

MAINTENANCE TRAINER (MT)

The Maintenance Trainer (MT) is the last step of the training for the ground technicians. It allows:

- a) training on a real aircraft mock-up and on-board systems without reducing real aircraft operativity and spare parts;
- b) utilization of simulated aircraft equipment by unskilled student to reach learning without danger for both the student and the real equipment with, as a consequence, a

maintenance cost reduction and an increase of real equipment effectiveness;

- c) introduction of simulated malfunctions by an instructor with a subsequent time gain in the preparation of the training session.

FLIGHT/MISSION SIMULATOR

The Flight/Mission Simulator is the last training step for the crew members before a real flight. The requirements of the simulator have to be defined considering the customer training needs. These are related to typical aircraft missions, tactical scenario, crew role and are defined with respect to the use of the simulators within the whole training centre.

If the simulator is correctly used within the training path, it gives technical and economical advantages:

Safety: the simulator eliminates risks for both the students and aircraft damages during the flight;

Training effectiveness: the simulator allows training for critical flight manoeuvres that are practically impossible to be performed on the real aircraft;

Money gain: the simulator is able to substitute a big amount of flight hours increasing real aircraft operativity; this leads to gain in: fuel, spare parts, reduction in malfunction on the real systems, reduction in the number of maintenance personnel on the ground, increase in in-flight utilization of the real aircraft.

COST/EFFECTIVENESS CONSIDERATIONS

With respect to typical training systems, statistical studies [5] have underlined how the effectiveness reached with new technology trainers is practically the same as with traditional trainers.

Meanwhile, these studies have identified the reduction of training time required for each advanced training system compared to the traditional method (Tab. 3).

The evaluation of the cost/effectiveness ratio for an integrated training system (not available yet) is independent from the single system ratio and is related to the whole training path.

EXPERT SYSTEMS: THE NATURAL EVOLUTION OF THE INTEGRATED SYSTEM

In an integrated training system the need of a control of the training path as a whole and for each training phase is critical especially for the optimization of each student training iter.

The possibility to introduce artificial intelligence methodology

will allow the creation of expert systems capable to improve the evaluation of student performance and knowledge during training sessions and, on the basis of a large Knowledge Data Base, to rearrange the training iter for each student and to give indications in order to better improve each training system and the whole training centre. To reach this goal the expert systems will increase their own capabilities automatically including new information based on students' experiences and defining new rules to manage the Knowledge Data Base.

At present, the CBT systems (just for their peculiarities) have been chosen as being the best systems suitable for artificial intelligence techniques applications: that is, to become the control station for management of the Integrated Training System (Fig. 6).

In such a context, in each phase of the training path will be applied the methodology of the whole integrated training system (Fig. 7); so, an improvement of the cost/effectiveness ratio for the whole training iter will be obtained.

CONCLUSIONS

The paper outlines the Integrated Training System methodology developed by Agusta Sistemi in order to satisfy the training centre requirements. Such a methodology is related to the complex management of several training systems, each of which designed for a peculiar task, but considered within a unique package called "training iter". To increase the learning evaluation and make more personalized the training iter, artificial intelligence techniques are needed: expert systems developed for such a task will be implemented on a training control station.

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	Traditional Learning	Innovative Learning
Goal	Acquisition of skills and behaviour needed to succeed in known, predictable situations	Acquisition of skills and behaviour needed to succeed in unknown unpredictable and unique situations
Measure	Better solutions to old problems	Innovative solutions to new problems
Reference	Past	Future
Behaviour	Conformity, uniformity	Divergence, Uniqueness
Information Flow	Top-down	Omnidirectional
Expectations	Predetermined	Expanding, Unknown

Tab. 1 Learning characteristics

		EFFECTIVENESS		
		less	equal	greater
yes = adopt				
no = reject				
? = uncertain				
COST	less equal greater	? no no	yes ? no	yes yes ?

Tab. 2 Cost/effectiveness criteria

EFFECTIVENESS	FACTOR	SAVINGS OR COST		
		FLIGHT SIMULATORS	COMPUTER-BASED INSTRUCTION	MAINTENANCE SIMULATORS
ABOUT THE SAME	STUDENT TIME SAVINGS	50% OF SIMULATOR TIME	30%	20-50%
	ACQUISITION COST	30-65%	?	20-60%
	OPERATING COST	8%	?	50%
	LIFE-CYCLE COST	65%	?	40%
	AMORTIZATION	2 YEARS	?	4 YEARS

Tab. 3 Systems cost/effectiveness ratios

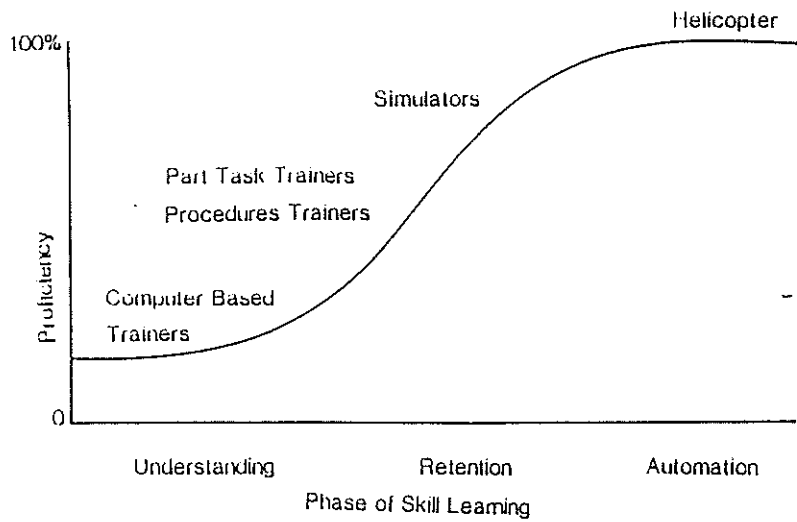


Fig. 1 Fitt's diagram

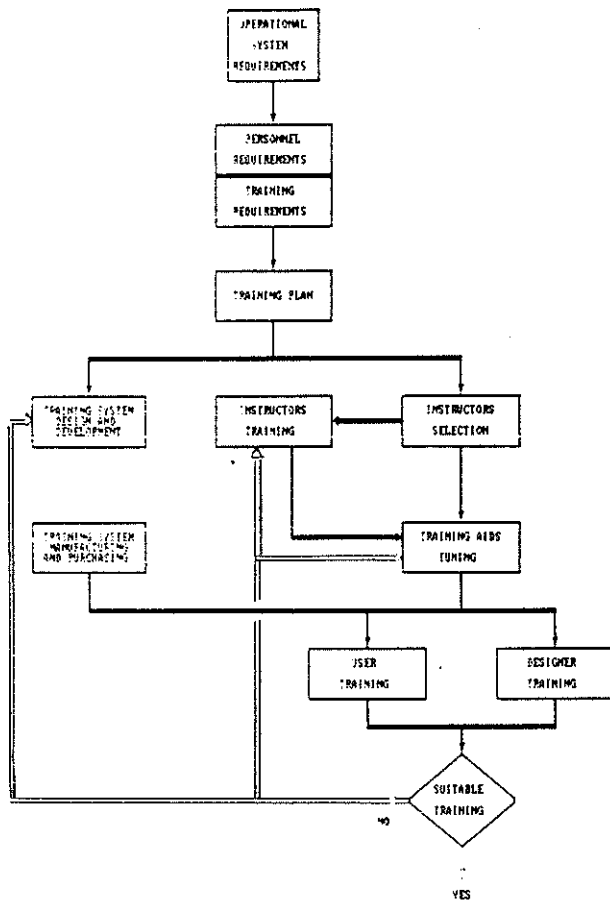


Fig. 2 Training process and knowledge evaluation

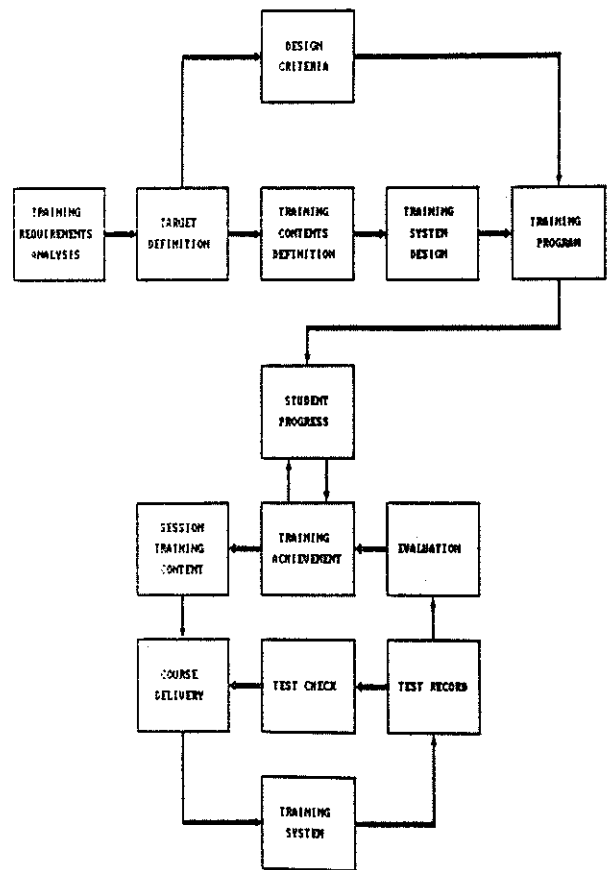


Fig. 3 Training procedure

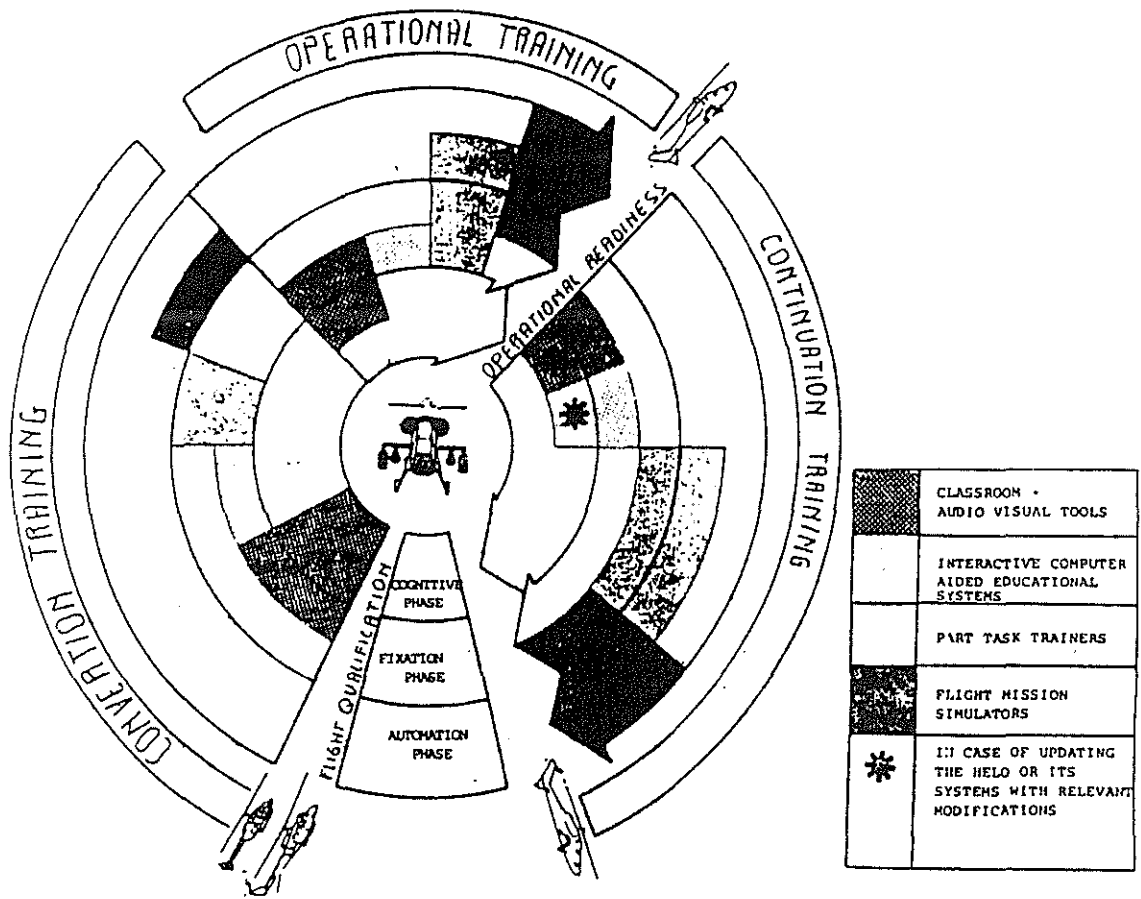


Fig. 4 Integrated Training System in an aeronautical training centre

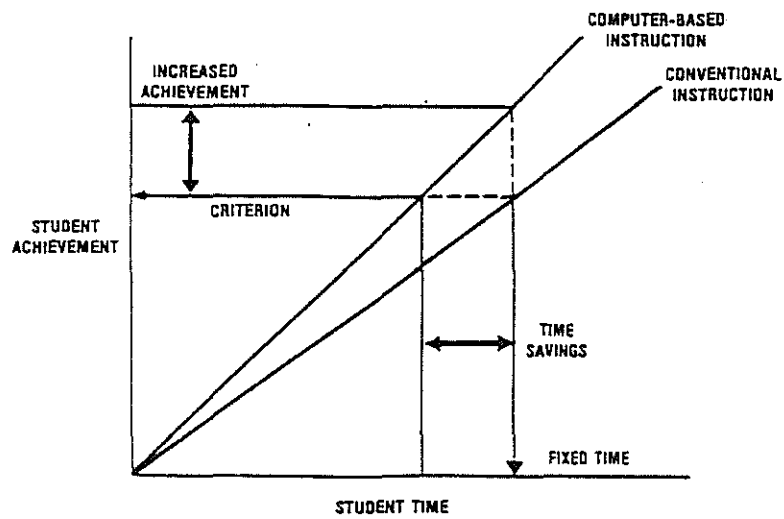


Fig. 5 Student achievement with CBT technology

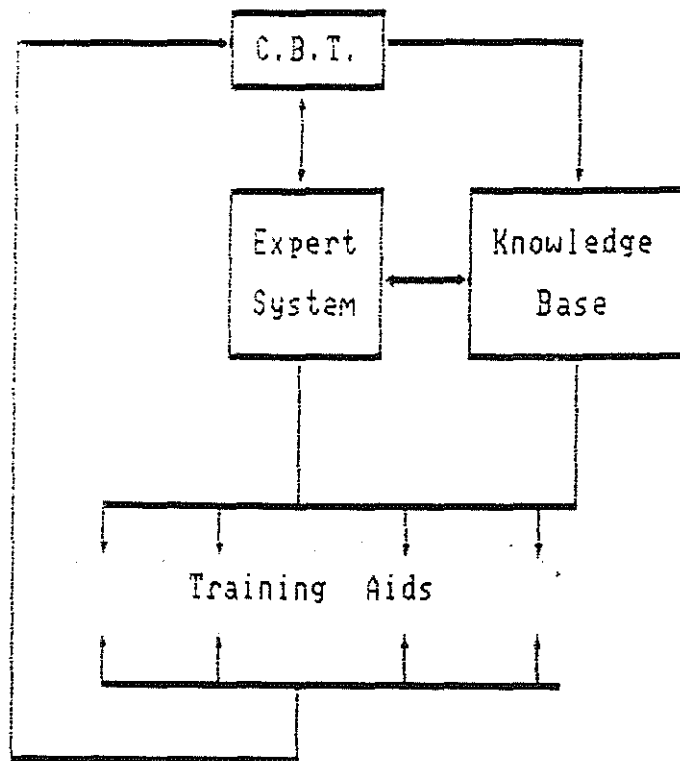


Fig. 6 Intelligent Integrated Training System

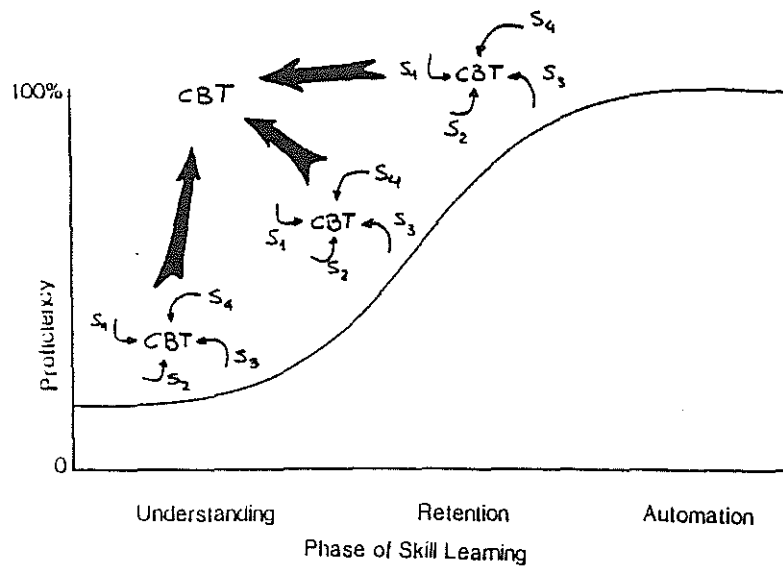


Fig. 7 Fitt's diagram for an Intelligent Integrated Training System