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AB212 MAINTENANCE TRAINER: A MULTIMEDIA APPROACH TO MAINTENANCE TRAINING

by

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Abstract

The paper outlines the Agusta Sistemi approach to maintenance training. The AB212 trainer is an example of that instructional philosophy that is focused to obtain an effective, flexible and easy to use classroom training environment.
The trainer is composed by a replica of the helicopter cockpit with simulated instruments and control panels, an instructor station with a rear-projected display unit and a student station based on a multimedia personal computer. The multimedia personal computer allows to control the delivery of information of different types: written texts, schematic, animated graphics, photos of helicopter components and movies of maintenance procedures.
The system simulates the operation of the helicopter systems both in normal and faulty condition.
The instructor can explain the operation of system using animated schematic and reproduce malfunctions selecting them on the instructor station.
Operating on the student station, the trainee can isolate and recovery faults choosing between possible maintenance actions and using a set of simulated test equipments.
The training environment leads the trainee:
- to learn and use a structured and rational troubleshooting
- to use correct maintenance and recovery procedures.

1. Introduction

Aviation is a dynamic environment where changes, technology evolution are very rapid and safety requirements play a key-role.
To face this dynamism and cope with safety requirements the aviation industry is asking for high standard of professionalism and qualification in every role from pilot to maintenance personnel. A structured and effective training is the basis to win this continuous challenge.

2. The Role of Simulation in Pilot Training

During the last years pilot training has moved from traditional "chalk and talk" lesson and flying training exercises to the use of Computer Based Training (CBT) and several types of

flight simulators, ranging from Part Task Trainer (PTT) to Full Flight Simulators (FFS), integrated with flight activities.
A simulation environment offers the main capability to train people in a safe environment allowing the trainee to receive feedback to their actions as in the real world. The simulator has the aim to allow trainee to gain knowledge and skills in less time, without risks and with a lower cost: it can be seen as a sort of experience accelerator.
The role of simulation is well consolidated in the areas of pilot and aircrew training where the flight trainers and simulators are commonly and widely used. The advantages of flight simulation is well known both on military and commercial aviation.

3. The Role of Simulation in Maintenance Training

The importance of simulation is growing also in maintenance training because of the increasing complexity of aircraft.
A well structured approach to troubleshooting and diagnostic assessment are main goals of maintenance training.
The maintenance engineer must gain a sound basic knowledge of aircraft systems and a confidence with the aircraft system functionality both for normal and faulty conditions.
A traditional approach to maintenance training satisfies these training needs usually with sandwich courses consisting of classroom activities and workshop activities.
During classroom lessons the instructor deals with general knowledge of the aircraft system and troubleshooting using training aids ranging from a simple blackboard and slides to functional models and synoptic panels related to the aircraft systems. The hands-on experience and qualification is then gained during on-job training in workshop with a supervisor that certifies the achievement of the required standard.
The training system described in this paper allows an enhancement of the traditional approach by means of an integrated and flexible classroom environment suited for familiarization and troubleshooting.
The most important features of this system are the simulation capability of aircraft system, the multimedia approach to training material and the high degree of interactivity with the user.

4. Maintenance Trainer Architecture

The maintenance trainer is composed of a Main Unit (MU), an Instructor Station (IOS), a rear-projected display unit (RU) and a Student Station (SOS). A layout of the trainer is shown on fig.1.

5. Main Unit

The Main Unit (MU) is fitted with the cockpit consoles and controls. It also contains the computing system. All the components fitted on the MU are located in their relative positions as in the cockpit. The MU comprise a number of active areas, namely the main instruments panel, the center console, the overhead panel and the functional items located on the pilot's primary flying controls.
The MU consoles and main instrument panels are fitted with functional and non functional items. The functional items are aircraft component or simulated components. Non functional items are represented by pictorial reproduction. The non functional items are duplicated co-

pilot instruments, controls and devices not needed to perform the requested training tasks. This arrangement allows an easier trainer update due to aircraft modifications.
The computing system consist of an IBM computer based on an INTEL processor/coprocessor interfaced with a set I/O board to the MU panels and consoles.
The real-time operating system and the simulation software is loaded and run on this computer.
The advantages of the computing system chosen configuration are the use of "off-the-shelf" hardware with high reliability, cost-effectiveness, high modularity that allows easy system expansion at low cost and with minimum changes to trainer configuration.

6. Instructor Station

The Instructor Station consist of graphic workstation with a graphic tablet and mouse, the instructor control monitor with a customized keyboard and a video switching unit.
The graphic workstation can be used to generate new training material or to show animated schematic of helicopter system or components. The animated schematic provides visual indication of the operation of the system. Instructor and trainee actions on the trainer has an effect and indication on the animated area of the schematic.
Using the video switching unit the instructor can show to whole class the animated schematic on the rear-projected display unit.
The instructor can select the mode of operation of the trainer and inject malfunctions with menu pages on the control monitor and using the customized keyboard.

7. Student Station

The Student Station consists of multimedia personal computer (PC) connected to the MU and to 37" TV set. The images shown on the PC monitor can be switched by the instructor (through the video control unit) to the rear-projected display unit.
Provision is made on the switching video unit to connect external equipment as a video recorder to show additional training material on the rear-projected display unit.
The user can interact very easily with the student station using a touch screen on the PC monitor.
The station can be used to familiarize with the helicopter system and test sets, perform troubleshooting and recovery procedures.
The user can select to watch movies on maintenance procedures and use of test set on the TV.
The video material consisting of still frame and movies is stored on a videodisc. The videodisc player is connected and controlled by the PC.

8. Training Environment

The training system allows an innovative approach to maintenance training: it brings the helicopter into the classroom.
Multimediality and simulation: that is the difference between a traditional classroom and the classroom environment using the AB212 maintenance trainer.
From the instructor point of view the maintenance trainer allow a great flexibility because the instructor can use different type of information (graphic, animated schematic, movie, photo etc...) with the best teaching strategy for the student's level of skill and knowledge.

The instructor can be extremely creative and modify the contents and the design of each training session to suit the different student's needs.
The design philosophy highlight and emphasize the link between the principle of operation, the functional logic of an aircraft system or component and the effect on the instrumentation and helicopter behavior.
The instructor can show how the system works and how it is operated using animated schematic and cockpit control panels and instrumentation.
The real-time software drives the cockpit instrumentation, control devices as in the real helicopter and modifies the animated schematic according to the instructor actions.
The instructor can inject a single or multiple malfunctions and explain how perform step by step troubleshooting and how to use test sets to measure parameter values in typical test points in the system using the multimedia PC.

If we now look to classroom environment from the student point of view we can see clearly the difference and the advantage of this approach.
The main advantage of this environment is to stimulate and increase the problem solving capability of trainee.
The typical training exercise deal with the recovery of failures.
The trainee analyze the effects of failure on the simulated cockpit. As a first step he has to choose which helicopter system he wants to check.
The instructor allows the access to student station and the first menu is shown on the PC monitor. This menu allows the selection of the mode of operation: familiarization or troubleshooting and fault recovery.

Familiarization mode is usually used by instructor during explanation phase to show how the system works.

When the troubleshooting mode is selected one or more menu pages are shown. On those pages the system components, on which maintenance actions can be performed, are listed (see Fig.2).
The trainee has on the bottom of the page a set of buttons that allows to go to back the previous step, to go to the next page, to connect and use a test set.
At this stage the trainee has to choose again. He has to choose if performing a recovery action on a system component or do further investigation on the causes of failure using a test set.
When he decide to perform a recovery action using a set of buttons as shown on fig.3.
The action listed allows to perform a correct maintenance procedure (i.e. visual check, remove part, change parts or the whole component). When the action is completed a feedback message is shown on the top of the set of buttons.
When the correct recovery action is performed the effect of failure on helicopter system is removed, the feedback to the student is the same of the real situation.

When the test set is selected a menu with the possible connection is presented. The trainee choose the connection and a graphic schematic of the items to be connected is presented. The student perform the connection touching the item to be connected. The fig.4 is an example of graphic layout of the screen.

When the connection is completed the test set can be used to perform the checks on the

component or the measure on the system.
An example of engine test set is presented on fig.5. The test set can be operated as the real equipment touching the selector and switches on the screen.

The trainer philosophy compels the student to develop a rational methodology to detect location and nature of the systems malfunctions and recovery the failure using correct maintenance procedures. A particular emphasis is given to this methodological approach that may be further stressed by the presence of instructor and the other trainees.
The practical skill to remove and to change components is gained during on-job training.

The opportunity to see sequence of maintenance procedure is offered when the student station is operated in the familiarization mode. This mode of operation allows the trainee to watch on the 37" TV set photos of the system components, test equipment and movies of the connection procedure of test set performed on the real helicopter.

9. Training Capabilities

The AB212 maintenance trainer enables maintenance specialist to be trained in the following:
- Cockpit familiarization;
- Ground running procedures including start-up, normal and abnormal running and shut down;
- Emergency drills and procedures;
- System controls and their effect;
- Systems faults diagnosis and recovery;
- Use of system test equipment.

The training systems enable the trainee to learn the diagnostic and corrective procedure associated with the following aircraft system:
- Engine and engine fuel;
- Fuel system;
- Hydraulic system;
- Electrical system;
- Navigation and communications systems;
- ASE/AATH system (Automatic Stabilization Equipment/Automatic Approach To Hover).

Engine and Engine Fuel

The two Pratt and Whitney PT6T-6 are simulated individually and the engines parameters are computed according to engine intake conditions and control setting. The engine performance computation take into account the effects of compressor airbleeds.
The engine test set and the turbine temperature indicating system test set are simulated.
The trainer is provided with schematic of the engine control system and cross section of the engine with animated airflow and engine parameters indicators.

Fuel System

The operation of the fuel tanks, pumps, valves, gauges and warning lamps are simulated.
The animated schematic provides visual indication of the operation of the fuel system

including the auxiliary tanks.

Hydraulic System

The three hydraulic systems are simulated with all gauges, indicators and possible captions. The operation with an external test stand is simulated and an active control panel of the test equipment is provided on the student station.
Animated schematic of the hydraulic system and cross section of the actuators are provided.

Electrical System

The AC and DC electrical systems are simulated so that generators, battery, indicators, switches and circuit-breakers can be operated as in the aircraft.
The value of voltages are computed at several test points where the trainee can carry out checks using a simulated multi-meter on the student station.
The electrical system animated schematic allows to visualize manual and automatic operation on the system.

Navigation and Communications Systems

The operation of navigation equipments is simulated with reference to ground maintenance procedures. The instruments in built-test are simulated and special equipment for TACAN test is functionally reproduced on student station.
The communications equipment can be operated as the real equipment but operational checks are provided only on some frequencies.
The intercommunication system can be operated between the trainee and the instructor to reproduce normal and faulty conditions.

ASE/AATH System

The ASE/AATH system is simulated to the extent necessary to ground maintenance operation. The dedicated test set, that is an especially modified test equipment to allow operation on ship, is simulated to allow training on maintenance procedures and faults isolation. Schematic of ASE/AATH control panel are provided.

10. Conclusion

The AB212 maintenance trainer is an example of a flexible and highly interactive training environment obtained with the use of simulation and multimedia capabilities of computers. We have now the tools to design and develop training systems that are focused to train maintenance personnel to a rational and structured approach to fault isolation and recovery.
The integration of multimedia technology into maintenance trainers is considered one of the more promising improvement for traditional training environment.
The use of graphic simulation for test equipment allows easier reconfiguration and updating of the training system.

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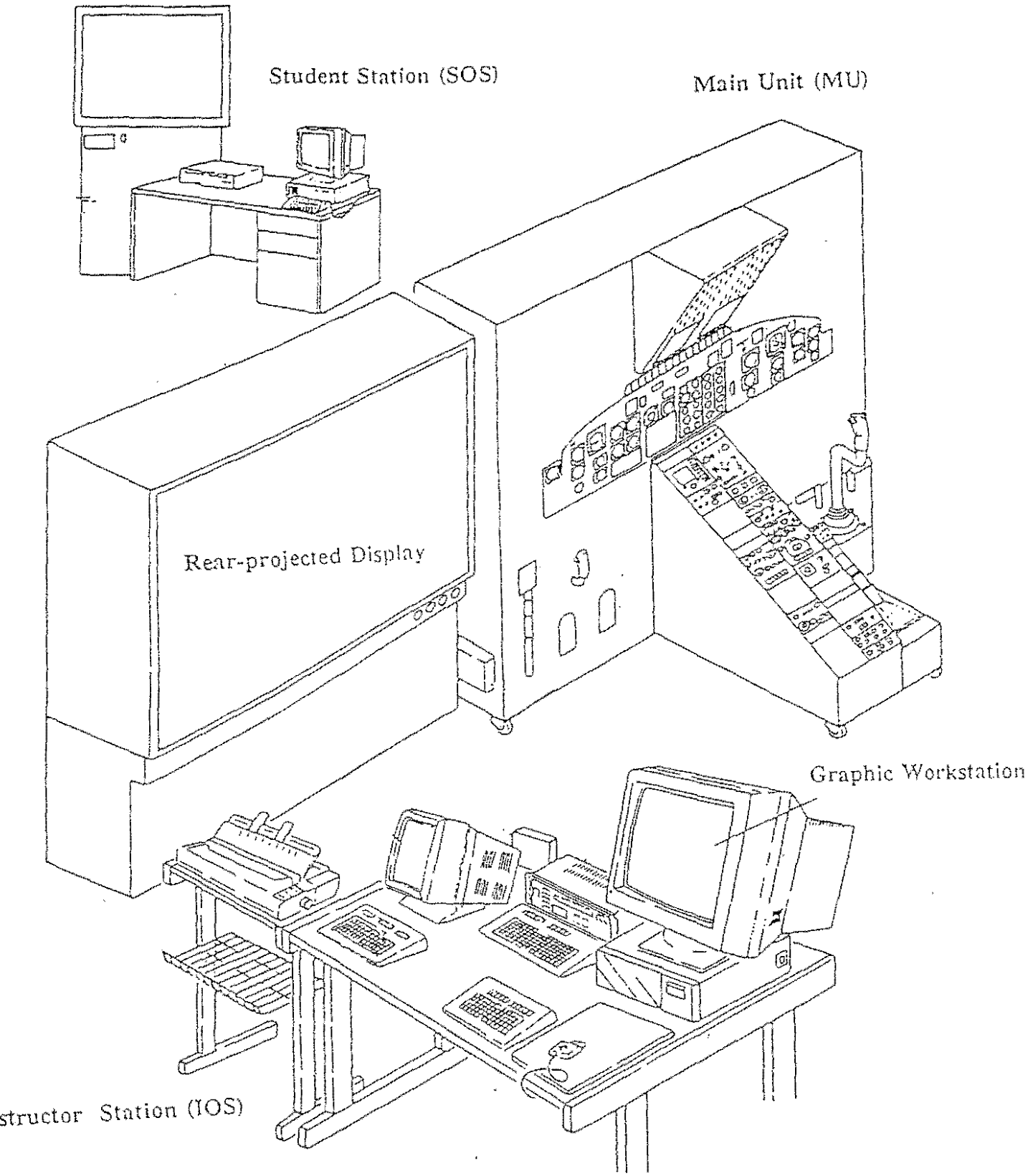

Fig.1 - AB212 Maintenance Trainer Layout.

Fig.2 - Menu for Selection of System Component.

1 - Mode of operation

2 - Connection and operation of test set

3 - Next page

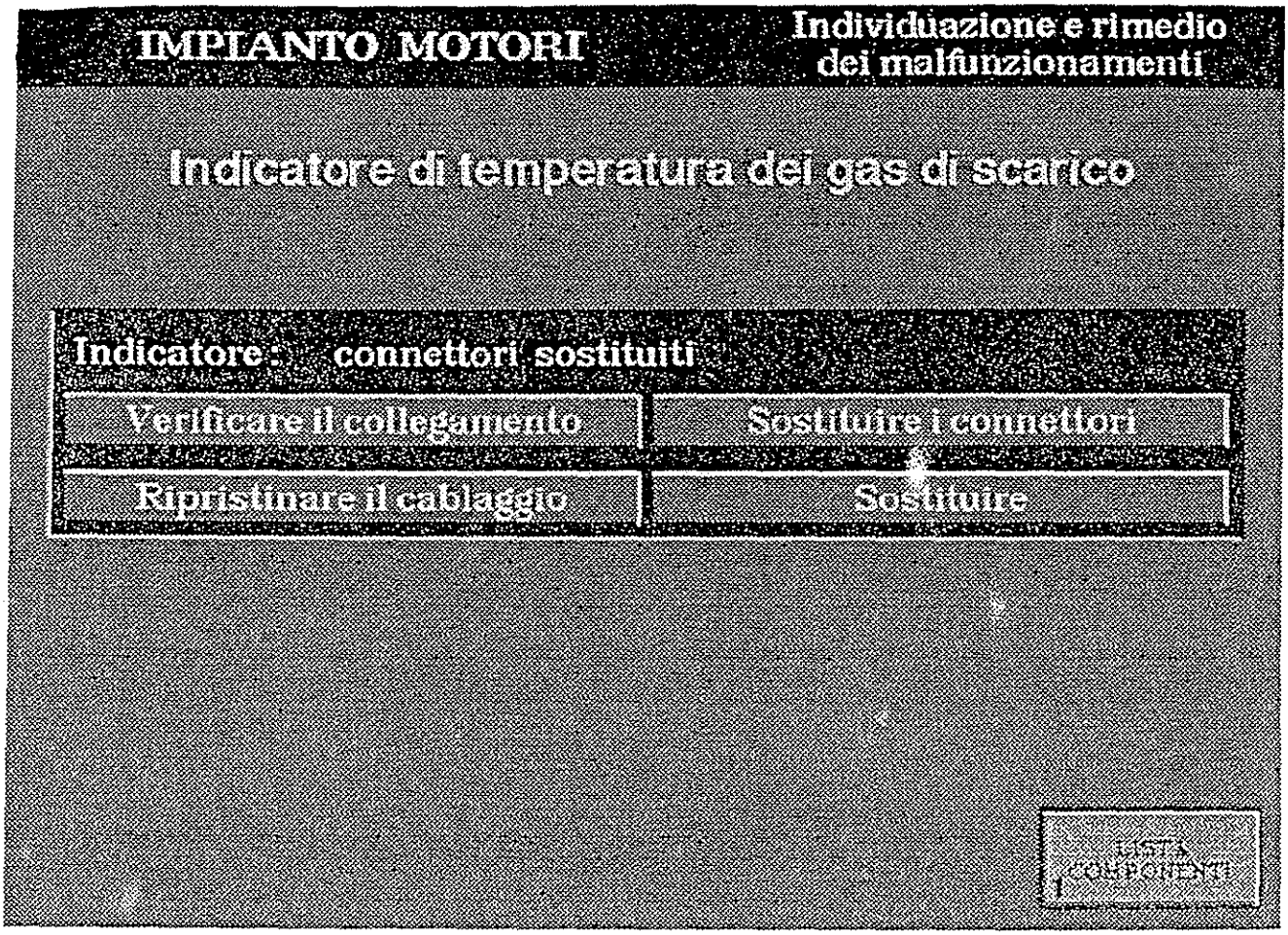

Fig.3 - Menu for Selection of Fault Detection and Recovery.

1 - List of components

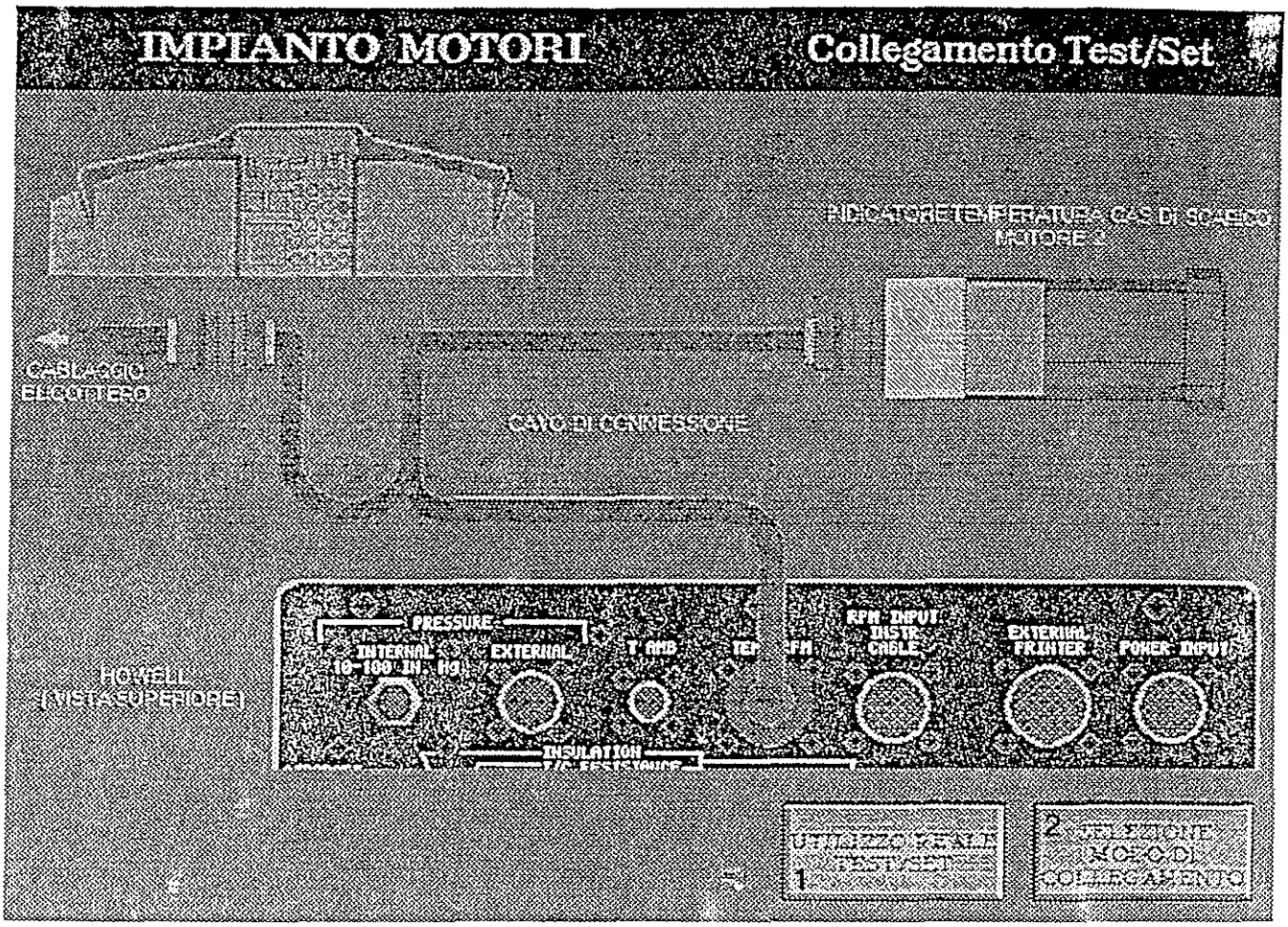

Fig.4 - Page for Test Set Connection.

1 - Test set operation

2 - Selection of test set connection

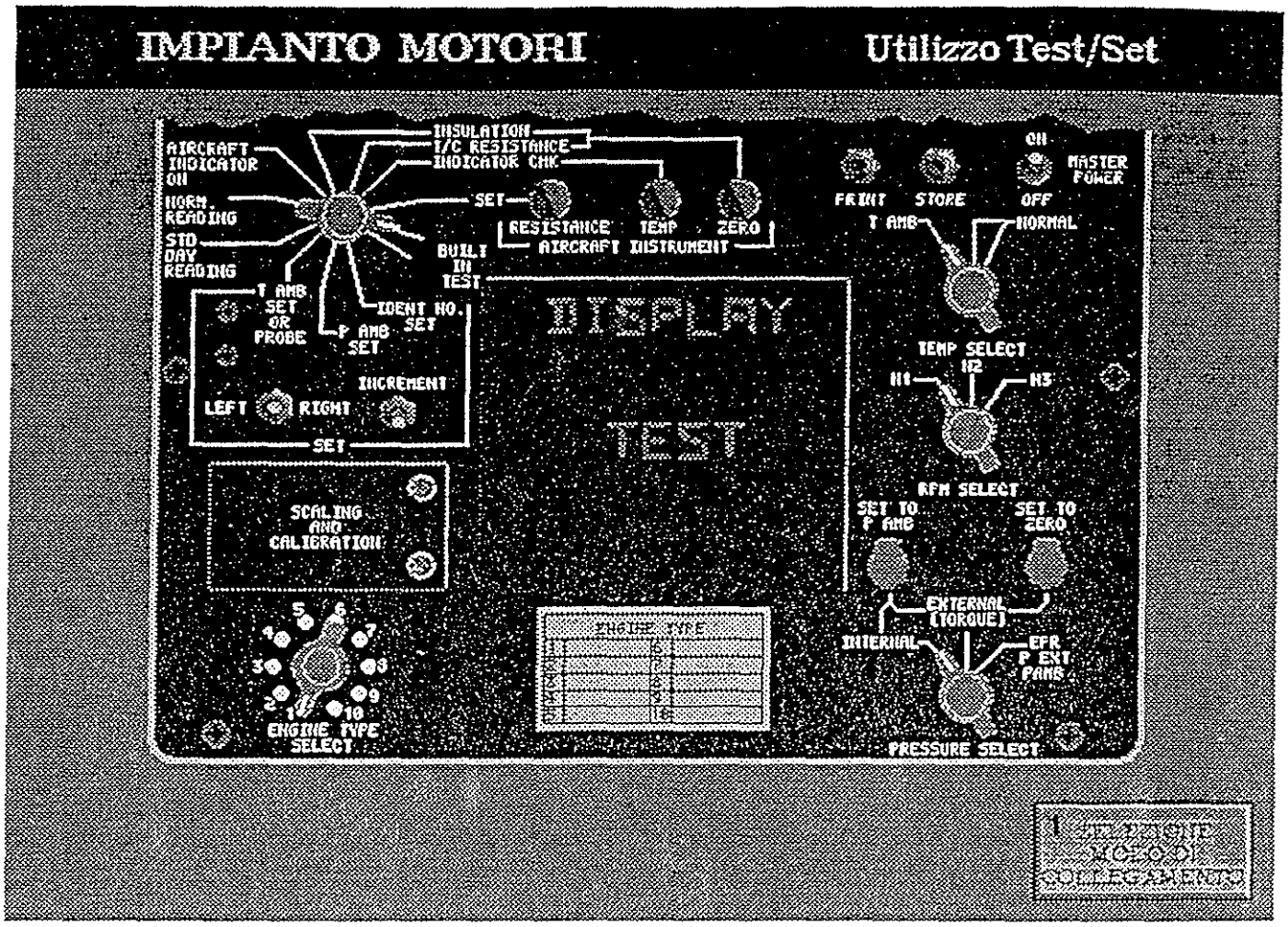

Fig.5 - Graphic Layout of Test Set.

1 - Selection of test set connection