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# TODAY'S AND NEW TRENDS FOR 1990'S: THE A129 TRAINING SYLLABUS

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## Abstract

The design of a new aircraft, whatever the application, cannot today be separated from the development of a training syllabus. The joint development of aircraft and training systems allows the constructive utilization of the mutual experience gained in the single design. Agusta has been aware, since the beginning of the A129 project, of the importance in offering a training syllabus together with the new anti-tank helicopter A129. For this reason the needs of crew and maintenance staff for the helicopter were analysed and, on this basis, various training systems were chosen as a function of the cost/effectiveness ratio. Due to this work Agusta is today able to offer a complete training syllabus, comprising Computer Based Trainer's (CBT's), Part Task Trainer's (PTT's), Maintenance Trainer's (MT's) and a Combat Mission Simulator (CMS) for the specified helicopter.

## 1.Introduction

The A129 is a helicopter devoted to anti-tank missions. For development of this helicopter all the most important technologies have been employed, both for the fuselage and the rotors, and for avionics and on-board computer. The result is a very sophisticated, high-tech machine capable to satisfy the most critical mission in the battlefield.
In particular the on-board computer, called Integrated Multiplex System (IMS), was developed according to the philosophy of concentrating all controls and functions usually distributed on several equipments. This allows a better control of the helicopter and a quick response to the external stimuli.
The whole project could not be separated from the development of an integrated training syllabus, driving crew and maintenance staff from basic knowledge to the complete preparation for a mission. For this reason Agusta studied a series of training systems, to efficiently bring students to an adequate level of preparation.

## 2.The Training Syllabus

Since the beginning of the syllabus design the problem of crew and maintenance personnel training was analyzed from different points of view. The first approach was, of course, the possibility of adopting traditional methods, mainly classroom lessons and functional mock-ups. This was the method followed until that time for Agusta helicopters personnel training, being Agusta's Customers not really interested to use other training systems. But the traditional training was facing to other problems, connected to the complexity of the machine and the level of avionics

sophistication. For this reason an overview of what available on the market was performed and several proposals from simulator manufacturers were analyzed.
What arose from this analysis was the possibility to distribute the training on several systems, each devoted to a specific task. But to clearly identify the appropriate system for the right step of training, time was spent to deeply analyze Customer requirements and propose an integrated training system capable to meet these requirements.
The work results led to design a preliminary training syllabus that was submitted to the Italian Army and, after Customer collaboration, the final configuration was established.
The study identified the major issues connected to the student's training. The first was the training on an unconventional on-board computer. Helicopter pilots are usually not familiar with high-sophisticated helicopter on-board computers and, in particular, for the A129 computer, where all functions are controlled by it. The second issue was the use of visionic systems. The A129 utilizes Forward Looking Infra-Red (FLIR) system and Integrated Helmet And Display Sighting System (IHADSS). Being these systems vital for survival in the battlefield, an appropriate training is required and particular training systems devoted to it.
These reasons led to the development of a syllabus that was capable to fulfill these requirements.
The training syllabus was devoted to training of both aircrew and maintenance personnel. They start from a common point that is Computer Based Training and acquire, in this way, a general knowledge of the helicopter. After this step training splits in two ways, respectively for maintenance and crew. Maintenance students complete their training on the Maintenance Trainer (MT), while aircrew practises the use of the on-board computer and visionic systems on the Part Task Trainer (PTT), to fulfill the final requirements and complete the training with the Combat Mission Simulator (CMS).
The design of this training syllabus, a scheme of which is shown on fig. 1, was also performed with the provision for the application of Artificial Intelligence techniques, for a quick and appropriate evaluation of the student performance. In this way a possible reconfiguration of the training path can be made easy and fast, with an adaptation to student capacity.

## 3.Computer Based Training

It is today recognized the importance to have a powerful and reliable system for the basic training of students. The training syllabus could not therefore start without the CBT, that uses computer technology for basic training.
The CBT is becoming more and more important with the application of various different equipment grouped together in a single trainer. This is what is called a multimedia system, that in case of the A129 application is formed by a personal computer with touch-screen, videodisk, headphone and several software support tools for student help, glossary and evaluation. Hardware is provided by WICAT and the same factory provides the authoring system, WISE.
The fusion between several different equipments is an important conquest for the best training to be performed. The use of videodisk, for example, allows for a good explanation of real systems, showing snapshots and movies of what is to be

described. Superimposed text provides the exact description of each part of the system, clarifying obscure aspect of the subject and giving the right indication of the position of each part of the equipment.
The utilization of animated graphics draws the student attention, improving the traditional lesson where often the student diverts his look and does not follow the lesson any more.
The implemented lessons for the A129 helicopter covers all systems mounted on the helicopter, realizing a course capable to provide the student with the general knowledge of helicopter parts and its functionality.
The covered aspects are:

* familiarization;
* hydraulic system;
* electric system;
* fuel system;
* transmission;
* composite material (for wing);
* landing gear;
* auxiliary systems;
* control commands;
* engines;
* Integrated Multiplex System;
* AFCS;
* navigation;
* communication;
* weapon;
* electronic warfare;
* visionics.

The personal computers are networked by a LAN and an instructor can control the classroom.
The instructor is enabled to assume the control of the lesson from his control console at any moment. He is provided with an evaluation tool and a real-time check that lets him to know the student performance during the lesson.
The student, from his seat, can ask for help but, if no problem arises, training is fully automatic.
The instructor is also provided with a large TV-screen where course images can be displayed and a traditional classroom lesson can be performed, utilizing CBT images as Computer Aided Instruction (CAI).
Fig. 2 shows a snapshot of the CBT class.

## 4. Maintenance Trainer

The MT is devoted to complete maintenance staff preparation and bring them to the field for normal maintenance of the A129 helicopter.
The trainer is composed of two different parts. The first is mainly oriented to the theoretical explanation of subjects by visualization on appropriate animated panels, the second to the practical application on fuselages, with relevant real-time

simulation.

Test Panels

The first part of the MT system training is composed of four panels, driven by microprocessors, and four back-projected screens.
Each training unit (panel and back-projected screen) has its own instructor station and is oriented to the description of one of the following A129 systems:

* engines;
* hydraulic system;
* electric system;
* fuel system.

Each unit is independent from the others and can therefore be utilized for training on the single system,
Panels are subdivided in the following areas:

- silk-screened area: supplies a scheme of the system with appropriate test points and buttons, to allow for the malfunction identification. After the identification the part of the system affected by this malfunction can be "removed" pushing the relevant button..

- Instrument area, where the simulated instruments relevant to the system are reproduced.

- Test Set Area, with active instruments and buttons. This allows the student to identify the malfunction injected by the instructor.

The system simulation is implemented on a Personal Computer. It allows the availability of a simulation system with limited dimensions, high performance and low cost.
To integrate PC performance, another computer composes the instructor station. It is the Computer Assisted System Trainer (CAST), with high level graphics characteristics. The CAST is used to reproduce schemes of simulated systems with high detail and animation in real time. The visualization of animated schemes is a very useful means for high efficiency of training. The simulation clearly indicates flow directions, pipe distribution, valves positions, etc. The images are displayed on the large back-projected screens.

Functional Mock-ups

The second part of the simulator is oriented to the practical application of notions acquired in the first part of the training.
It is composed by the following units:

- Two simplified fuselages of the A129 helicopter. These comprise a reproduction of the general helicopter frame and a series of replaceable units (LRU) with the

same external dimensions of the real ones and all controls and indicators completely simulated.

- Maintenance Test Set for each mock-up, completely similar to those present on the front panel and all controls and indicators simulated.

- A computing system for each mock-up, with relevant interface boards.

- A control display for each mock-up with relevant keyboards.

The two units have similar configuration but substantial differences. The first is utilized for maintenance of general systems (engine, hydraulics, electrics, fuel), the second for training on navigation and weapon maintenance, particularly important for the A129.
The simulator control is realized by two control stations, based on SYP302. In this way communality with MT is assured. But the computing power, being particularly important for simulation of various equipment is given by two ENCORE 32/67 computers. The same computers are also used for the CMS, in this manner assuring communality also with the simulator.

5.Part Task Trainer

The specialization required from helicopters to operate on battlefield pushes designers to supply the helicopter with very high-tech systems, with the result to have powerful systems, but requiring time for a deep knowledge of the single system. To facilitate the familiarization of aircrew with these systems, PTT's for training on the IMS (on-board computer) and visionic systems have been designed and supplied.
The fig. 3 shows a snapshot of the system. A Trainee Station reproduces in real dimensions and appearance the pilot cockpit of the A129. The instruments are reproduced but they are not working. The IMS is partially simulated: only the partial populated Remote Unit of the real on-board computer is used, exploiting the board that reproduces symbols and messages. The multi-function keyboard and the display are also real. The Instructor, from his instructor station, can control the training session, with the possibility to inject malfunctions and stop the training if very heavy mistakes are performed. To obtain the communality between systems, also in this case the SYP302 PC is used, with a special board devoted to interface the IMS.
The same PTT is also used for training on visionics system. The training is essentially based on the IHADSS, that allows the student to see the out-of-the-window scenario also during night and low-visibility flight. A videodisk is used to reproduce a movie that familiarizes the student on the use of the IHADSS.

6.Combat Mission Simulator

The use of CMS is mainly devoted to training aircrew in flight and mission. To meet these requirements a very sophisticated and high-tech simulator was designed and developed. In particular the following aspect must be treated for training:

- Helicopter handling in VFR;

- Instrument Flying procedures;

- Tactical Environmental handling (day and night);

- Weapon Aiming and Delivery against static and mobile targets;

- Mission handling including approach, target acquisition, engagement and disengagement;

- Operation of the Avionics, communication, visionics, tactical, ECM, laser and NBC systems.

The simulator, whose an artist's impression is shown in fig. 4, is configured with two cockpits, each mounted on its individual synergistic six-degree-of freedom motion system. One is a replica of the pilot's cockpit and the second a replica of the co-pilot/gunner's cockpit. A visual system is mounted on each motion platform.

The simulator can be operable in the following modes:

- Mode 1 - Independent Mode: this mode enables each crew member to perform independently of the other. Full Flight and Systems simulation capability is retained in each cockpit with Instructors (at the Instructor Station) providing "other crew" inputs as required.

  In this mode of operation the two cockpits can be operated independently as if they were each part of a separate complete helicopter. They may operate in the same or different airspace and do not interact with each other or be visible to one another either electronically or optically.

- Mode 2 - Combined Mode: In this mode the two crew stations perform in unison - as if both crew members were sharing the same helicopter. The two crew stations are fully interactive allowing normal crew training to be performed.

- Mode 3 - Joint Mode: As in mode 1, the two aircrews operate independently of each other. Where necessary an instructor can act as a supporting crew member. However in Mode 3 the two simulators are visible to one another both optically and electronically. The crew members can then perform joint missions and play supportive or opposing roles as required by the training syllabus. In effect, each crew member has the benefit of "flying" with an instructor in realistic war and peace-time scenarios.

- Mode 4 - Proficiency Mode: Operations in this mode enable aircrew to retain their proficiency. All facilities provided in Mode 2 with the benefit of radio communications from a range of scout helicopters flying in supportive role. The scout helicopters is represented by the instructors who act as scout-helicopter aircrew by providing appropriate communication links. The scout

helicopters may be programmed into the scenario and therefore should be included in the visual scene when operating within the "out-of-the-window" field of view from either cockpit.

In order to provide the above simulation modes, the simulator is configured with two separate cockpit assemblies each with their own motion and visual system. These operate together in integrated modes. They provide each crew member with individually computed motion, visual and aural cues. The motion system attitudes and accelerations are computed separately for each crew member as a function of the relationship between each crew member's head and the centers of gravity of his helicopter. Each visual scene should be generated to suit the appropriate crew member's eye position. Similarly, independent aural cues are generated as appropriate.
During independent crew training, the cockpit systems, motion systems, visual systems and aural cue systems operate independently. This approach ensures that each crew member has the benefit of full realism in these areas. Each cockpit is controlled by separate elements within the computing system. The simulator is controlled by an off-board computing complex comprising advanced state-of-the-art super-minicomputer and peripheral devices. The motion systems are accurately synchronized with the visual systems, simulated flight systems, avionics, rotor blade element theory models, weapons and aural cue systems to provide the correctly coordinated range of haptic, vestibular, visual and aural cues necessary to create the realistic high-fidelity training environment required to meet the full range of the specified training and tactical development tasks.
In all modes is possible to "fly" the simulated helicopter under the control of a pre-recorded Automated Training profile.
The simulator development has been performed from Agusta as prime contractor, Link-Miles as Basic Simulator supplier, and General Electric as Visual System supplier.
The Integration and Acceptance of the simulator is Agusta responsibility. Agusta is also the designer and developer of peculiar parts of the simulator: the data collection (data package), the simulated aerodynamics, the systems simulation and the interface between the simulation computer and the on-board computer. As far as this on-board computer is concerned, it was utilized in "stimulation" mode, that is stimulating the real system. In this manner, in case of new release of the computer software, it can be easily substituted in the simulator.
General Electric provide the simulator with COMPU SCENE IV visual system, one of the most sophisticated visual systems available in the world. It was chosen for the importance of visual system in a helicopter flight simulator, where, due to Nap-of-the-earth flight, also the single detail of the scenario is easily seen by the pilot.
The simulator is designed to provide the trainee pilot with 50% of VFR flight, 100% of instrument flight and 80% of night or poor visibility flight training requirements. In addition the CMS provides 70% of the requirements for joint aircrew training.
In order to provide 100% total training the balance of flight training should be performed in real flight thus complementing the CMS training.

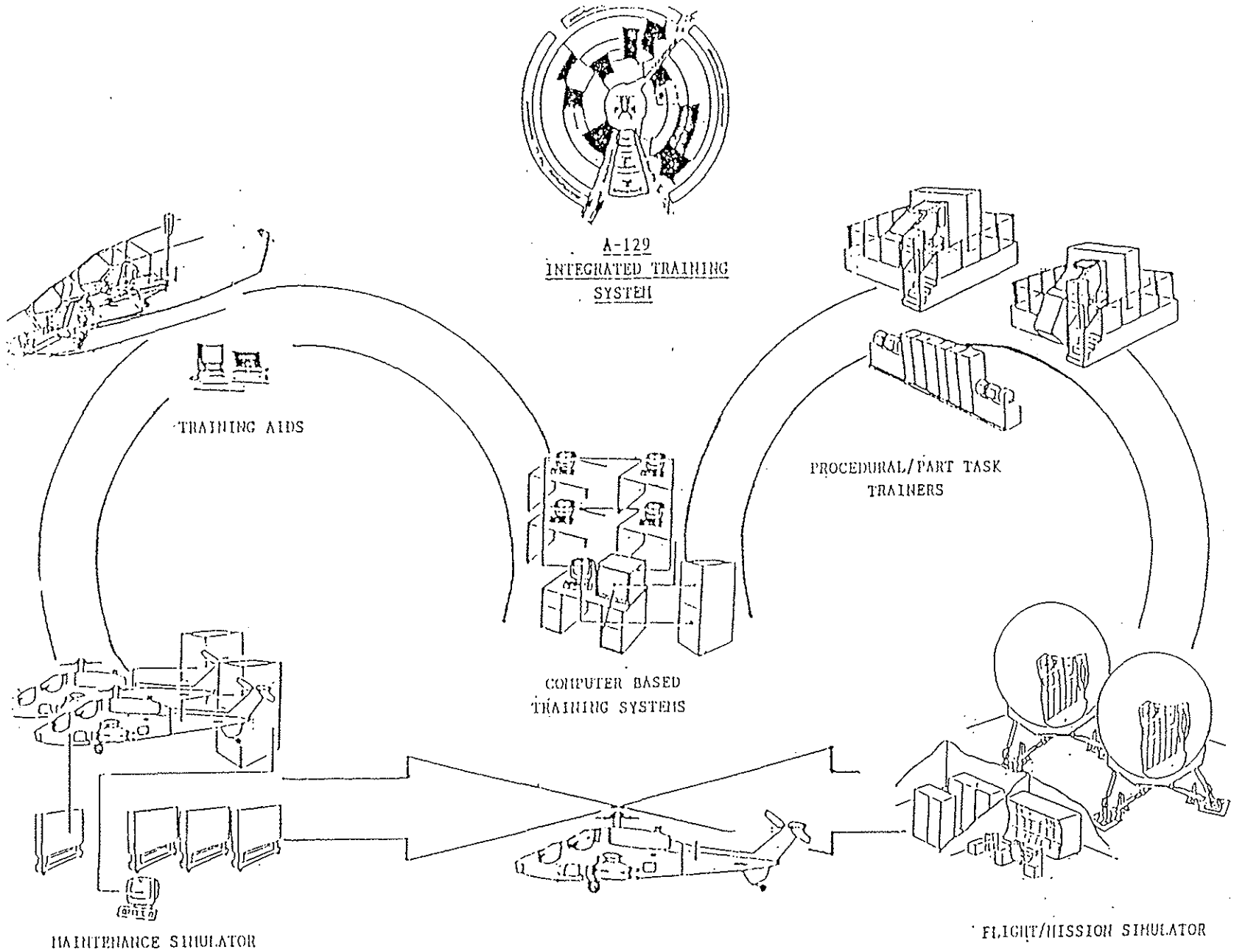


FIG. 1 - THE A-129 INTEGRATED TRAINING SYSTEM

FIG. 2 THE CBT CLASSROOM

FIG. 3 THE PART TASK TRAINER

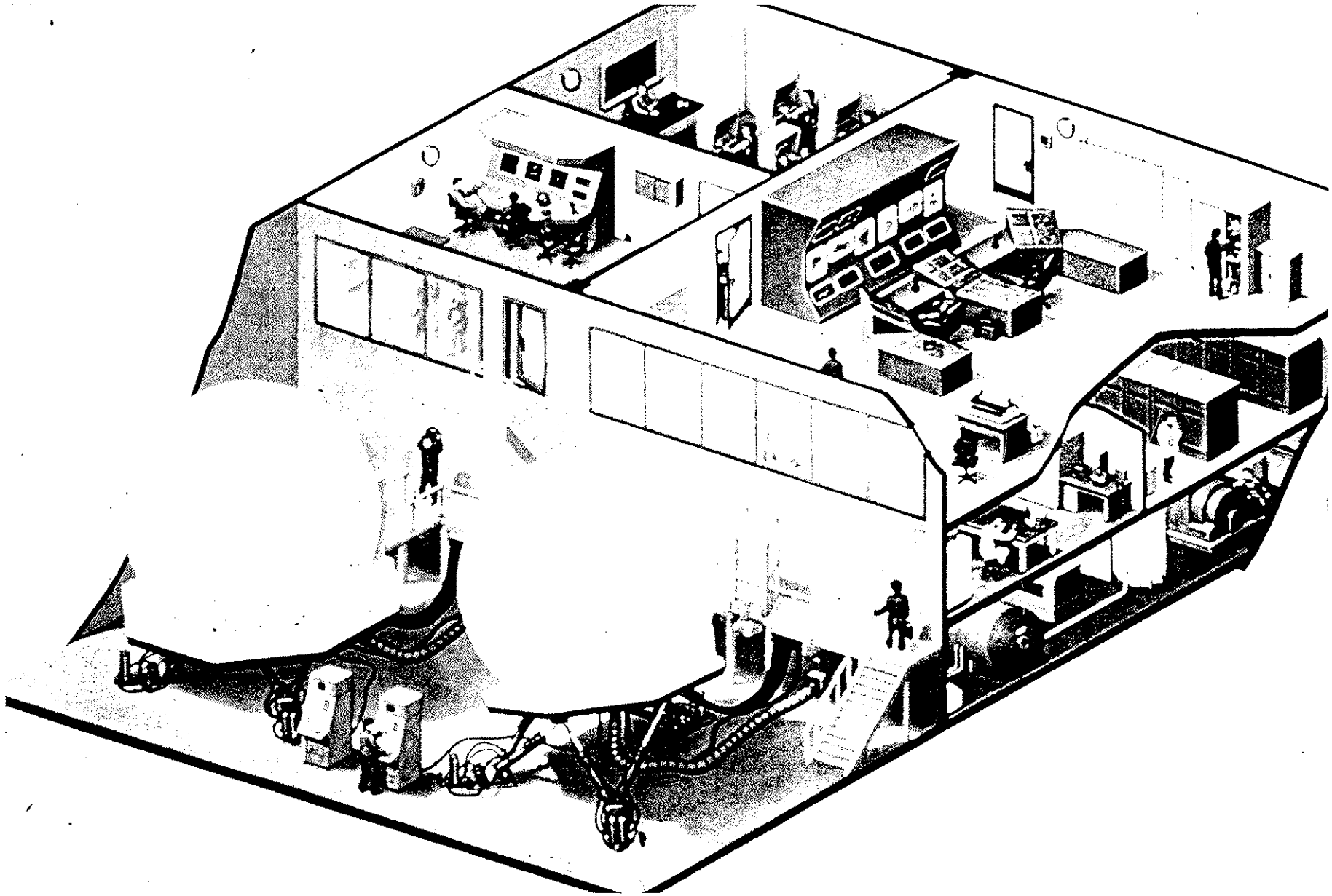

FIG. 4 ARTIST'S IMPRESSION OF THE COMBAT MISSION SIMULATOR