TEST CONCEPTS APPLIED TO FRENCH ARMY EQUIPMENT

IN THE FIELD FROM 1990 TO 2000

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SYNOPSIS

The proposed paper presents the maintenance solutions that will be implemented by the French Army in the intermediate level for equipment of the 1990-2000 generation.

After summarizing the experience acquired from the preceding generation, the paper describes the procedure applied to arrive at the definition of the requirement and the characteristics of the resulting test system.

1 SUBJECT

The subject concerns the maintenance facilities used at the second maintenance level, otherwise called intermediate level.

2 EXPERIENCE FROM THE YEARS 1980 - 1990

The French Army developped the DIADEME program for the test of its electronic equipments of the 1970 - 80 generation.

This program, which is based on the concept of a single mobile tester, covers the following equipment :

- COTAC (AMX 10, AMX 30 battle tank fire control system),
- RITA (Integrated Automatic Transmission Network)
- ATILA (Fire Automation and Artillery Liaison System)
- VOA (Artillery Observation Vehicle)
- HOT (Anti-tank missile)
- Helicopter-borne Inertial and Radio Navigation Systems
- Electronic Warfare systems
- Radio sets

The DIADEME station consists of a test substation containing seven electronics bays installed in an air-conditioned 20-foot shelter and an ancillary substation containing storage and drawers for the spares.

As the composition of the electronic bays differs according to the equipment to be supported, five different station configurations have been defined.

The DIADEME program was launched in 1978 and went through the following main phases (see figure 1) :

- a preliminary design to validate the concepts,
- a development phase that resulted in the construction of a room-based prototype and a shelter-borne prototype,
- tactical experimentation that consisted of full-scale tests including transport, operation in the field and running of a test program,
- the supply of workstations for program development,
- the development of 200 test programs. These programs were written by the companies responsible for equipment development, either in a programming center or using testers supplied to them,
- the production of 50 operationel stations for use by the French Armed Forces.

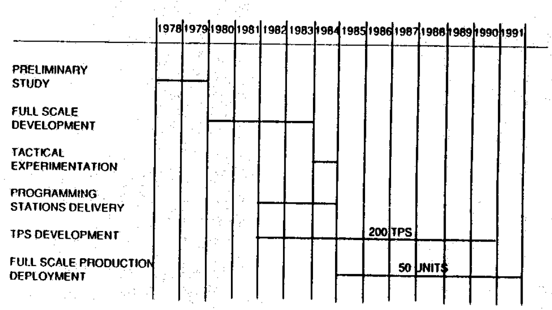
1990 was a year of entry into service and operator training, with 30 stations and a hundred or so softwares becoming operational before the end of the year.

At the end of this period, the results were 2500 LRUs tested and a return rate of 10 % to shop level.

By the end of 1991, 40 stations and 140 softwares will be operational with a target of 3000 et 4000 LRUs tested.

The final target is a total of 195 softwares in service.

Two DIADEME stations were used in the DAGUET operation during the Gulf Conflict : they accumulated 700 operating hours with an MTBF of 300 hours.



DIADEME PROGRAM

FIGURE 1

3 DEFINITION OF REQUIREMENT

The equipment to be tested is that of the 1990-2000 generation.

The analysis of the definition of requirement has been conducted on the following weapons systems :

LECLERC	New generation battle tank
AC3G	Third-generation anti-tank missile
ORCHIDEE	Battlefield observation system
SAMANTHA	Anti-aircraft alert and control system
PR4G	Fourth-generation radio system

In order to reply to the two following questions :

- is it necessary to keep a second maintenance level ?
- if so, what facilities are required ?

To conduct this analysis, the equipment was considered from the two basic aspects :

a) Its technology :

digital
hybrid digital/analog
electromechanical
optronic
RF

SPREAD OF TECHNOLOGIES EQUIPMENTS BROUGHT INTO SERVICES IN 90-95	
DIGITAL	19 %
DIGITAL/ANALOG	29 %
ANALOG	26 %
ELECTROMECHANICAL	13 %
OPTRONIC	11 %
RF	2 %

FIGURE 2

b) Its self-test capability

This preliminary study was conducted in 1988, with 132 LRUs examined. Figure 2 shows the spread of technologies of the equipment examined.

It shows a proportion of digital or mostly-digital equipment amounting to 48 % which, although it is certainly high and increasing steadily, does not yet represent the majority.

It also shows an 11 % proportion of optronic LRUs, which did not appears in the preceding generation.

From these figures and the self-test capabilities that were examined and that are directly linked to the proportion of digital technology, the following conclusions were reached :

1. For the electronics :

- The conditions for eliminating the second maintenance level have not been met :
  . the built-in tests are note powerful enough
  . the electronic boards are note suited to replacement in the field.
- When the conditions have been met :
  . it is not the case for all the equipment of a weapons system
  . various generations of weapons systems are obliged to exist side by side.

2. For the optronics :

- it is possible to conceive a universal tester,
- it is possible to perform the repair in the field.

3. A multipurpose tester for each support point remains preferable to several dedicated testers.

In fact, multipurpose testers have greater operating flexibility as they adapt more easily to the organization of the regiments supported and they are of course fewer in number.

4. Board screening is an interim solution before the elimination of second level maintenance.

Board screening is a process that does not significantly increase test resource requirements and can be used to perform maintenance at two levels on equipment which is designed for this purpose but whose self diagnostic performance is not yet satisfactory.

4 THE PLANNED TEST SYSTEM

4.1 MAIN FEATURES

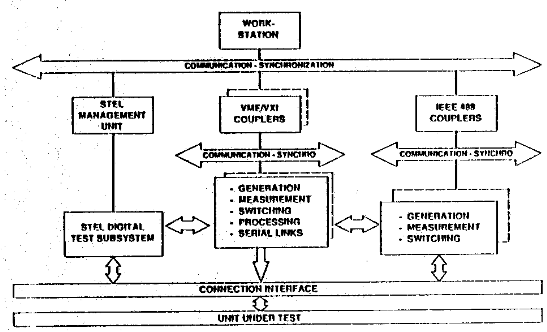
The major orientations are as follows :

- equipment and board capability
- test capacities :
  . analog up to 18 GHz
  . digital up to 40 MHz
  . optronics
- use fo the following standards :
  . ATLAS 716-89
  . VXI
  . UNIX
- on-line documentation processing capability
- self-maintenance capability with repair of the tester's boards
- management of repair data.

4.2 SOLUTIONS CHOSEN

4.2.1 Tester architecture

The general architecture of the tester is shown on figure 3.
It is broken down into three subsystems :
- the data processing subsystem consisting of a workstation and its peripherals,
- the digital test subsystem,
- the analog test subsystem consisting of racks with their own local bus which can be either a VXI or IEEE bus.



ARCHITECTURE

FIGURE 3

The exchanges between these various parts are performed through a high-speed digital bus which can be used for communication between the central computer and the other subsystems or racks and for communication and synchronization between the racks themselves or, between the Digital Test System and an analog rack.

The DTS management unit is responsible for sequencing the DTS commands, monitoring its resources and exchanging data with the central computer.

The couplers of the analog racks dot not play an active role. They are simply transparent bus translators. Local intelligence, when it is necessary, is either set out on the instrumentation modules or is provided by dedicated modules that can work on behalf of local instrumentation modules or thoses located in other racks.

The advantage of this architecture is that, from a functional point of view, it represents an association of facilities that are interconnected at the same level.

This architecture offers the maximum capability for exchanges of data between the various components of the system, whatever their role, and therefore provides the best distribution of tasks between the various processors of the system for a given function.

4.2.2 Software architecture

Figure 4 shows the general organization of the software tools , with the tools designed for test program development and the tools used in operational service.

4.2.2.1 Developpement tools

All the development tasks are managed by a set of software facilities which are used to :

- control the sequencing and planning of the execution tasks for the various test programs (PROJECT MANAGEMENT),

- assure the coherence between the various elements created during the development (SOFTWARE WORKSHOP). These elements are for example : the source and object programs, the simulation results, the documentation (functional, organic, implementation) the connecting tools, their files, etc.

The general development management facilities also include quality measurement tools which are used according to a methodology suited to the project.

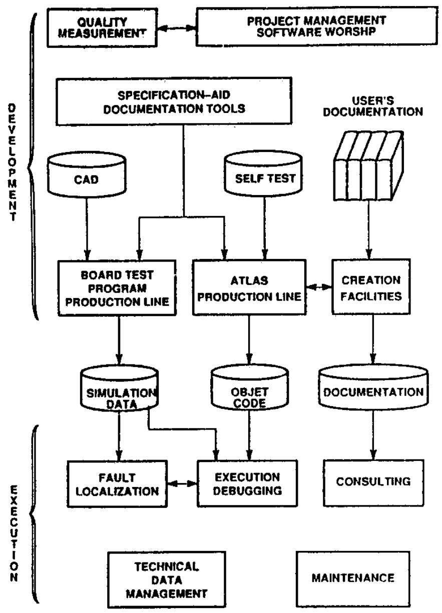
To execute the initial development phases of a test software, specification-aid tool are included that allows to formalized the test program design phase. The use of such a tool gives a better view of the suitability and completeness of the solutions chosen and better development traceability.

Editing and documentation tools for production of the ATLAS source program are also available during these phases.

The program created at this stage may follow the classic path of the ATLAS production line (compilation, link editing, execution simulation, etc.) possibly incorporating the self-test data output by the LRU development lines. The result is an object code that can be executed on the tester. This is the path normally used for the LRU test softwares.

For boards, whether GO-NOGO programs alone or GO-NOGO programs with fault isolation are concerned, a board test program specific production line is included which uses a logic simulator and allows a digital test program to be debugged without the need of the configured tester. If the board under test has been developped using CAD facilities, it is possible to retrieve its description and any stimuli according to a process that is described below.

To finish with the development phase, it should be noted that creation facilities in the form of a documentary base image are provided. This image will contain :
- the documentation for the LRUs
- the operating documentation for the test stations.



SOFTWARE ARCHITECTURE

FIGURE 4

An ATLAS program may refer to the drawings or figures of the LRU documentation (or the drawings made using editing tools), for example to illustrate an operating procedure during the test.

4.2.2.2 Execution tools

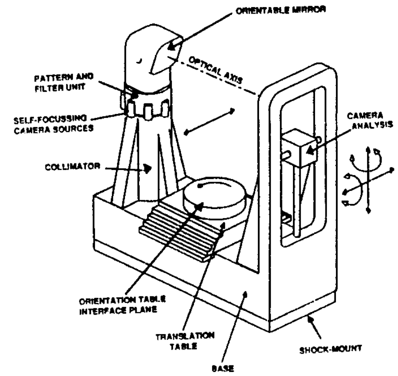
The tools used at this level primarily include the executives responsible for running the tester according to the commands of the operator and of the object program resulting from the previous phase. They are supplemented by the debugging tools designed to allow an efficient check of the machine and to provide good visibility of the tester and program statuses.

The execution of the test programs with fault isolation is performed under the supervision of automatic fault isolation tools which enable the faulty node or component on a board to be located.

The facilities available in operation are supplemented by a technical data management software (station logbook, stock management, etc) and maintenance tools (self-test and calibration programs, etc.).

4.2.3 Electro-Optics subsystem

For tests and intervention on electro-optics LRUs, a multipurpose optics test bench is installed in the clean zone (see figure 5).



ELECTRO-OPTICS UNIT

FIGURE 5

This bench consists basically of the following :

- a source focussed at infinity (multispectral collimator),
- a fixture for positioning the LRUs in front of the collimator,
- a system for detecting and measuring the collimated source seen through the LRU under test.

This type of test bench is used to handle LRUs of considerable size and weight, it has a compact design so that it can be integrated in the shelter.

Even in its basic version, it is coupled to an equipment for processing images and interpreting the results.

The concept of the electro-optics station is based on and is justified by the generalized use of image processing methods.
This is in order to :

- make the working methodology as universal as possible,
- limit the quantity and diversity of the equiment and accessories required,
- reduce the intervention time on the LRUs,
- increase the reliability of maintenance operations by eliminating the subjectivity (inherent in optics tests) of the personnel,
- allow the station to be run by non-specialized personnel.

The test bench has five main functions :

4.2.3.1 Source function

This is used to generate an object at infinity in each of the spectral bands. Its consists basically of the following :

- the collimator,
- the sources
- the filters
- the test patterns.

a) Main features of the collimator

- collimator characteristics : diameter 200mm and focal length 1200mm, determined to handle all the LRUs of the reference weapons systems
- collimator mounted vertically to reduce the surface area occuped and guarantee good benchidity
- mirror set out on the base.

b) Characteristics of the sources, filters and test patterns

Considering the high number of sources, filters and test patterns, use will be made of manually-adjustable cylinders to avoid complicated handling operations :

- one cylinder containing all the test patterns,
- one cylinder containing all the filters,
- one cylinder containing the sources required for this setup.

c) Characteristics of the steering mirror

The optical axis of the collimator is deflected to the horizontal plane by a 45-degree steering mirror measuring 200x400mm.

About its nominal position, this mirror is :

- orientable in elevation and azimuth by two angular movements
- adjustable in height by a vertical translation movement.

These three movements allow the optical axis of the test bench to be set to :

- the geometrical datum lines of the LRU under test
- the optical axis of the channel under test.

4.2.3.2 The support function

The support part accomodates the LRU assembly mounted on its specific attachment tooling and, owing to the tooling design, sets it roughly with respect to the optical axis of the test bench.

It comprises the following :

- one translation table wich assures the horizontal optical setting perpendicular to the optical axis of the test bench (see above),
- one interface plane compatible with all the LRU attachment tooling,
- one manual-control turntable that can be set with good repeatability, the only function of which is to facilitate the operator's access during work on the LRU.

4.2.3.3 The detection function

Depending on the tests, the detection function is performed by the following :

- one analysis camera : image reading camera (with its lenses) capable of aligning itself with the optical axis of the test bench at the optical channel output of the LRU under test.
  The alignment is performed by a camera support with :
  - two degrees of translation freedom in the horizontal plane to the optical axes,
  - two degrees of rotation freedom : elevation and azimuth.
  - one autocollimating camera : image reading camera (with its lenses) set out on the exit lens of the collimator
  - direct video link when the LRU already has image reading.

4.2.3.4 The measurement function

The measurement function is performed via the means of dialog with the tester, including :

- a screen for :
  . editing the results and illustrating the test instructions and procedures
  . directly displaying the video image of the test in progress,

- a command keyboard and mouse,

- a control unit for the electro-optics test bench including the control and safety devices.

The arr angement of the test bench allows the following :

- access to the item under test on the maximum number of sides (4 or 5 thanks to the "turntable") in order to facilitate manual operations,

- access to the console (display and commands) whatever the working area of the operator around the test bench.

4.2.3.5 The control and computation function

The control and computation function performs the control of the optics test bench by the test system :

- automatic sequencing of the tests,
- analysis of the measurements by the processing modules,
- selection of the instructions,
- check that the instructions are executed correctly.

4.3 SCHEDULES

Figure 6 shows the planning of the DIADEME 2 program for the LECLERC battle tank.

The Full Scale Development phase will take place from September 91 to September 94.

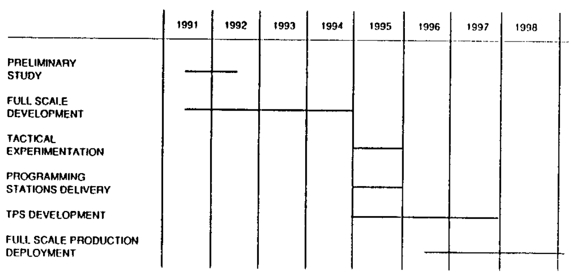
Tactical exprimentation identical to that performed for DIADEM 1 is planned for 1955.

For the requirements of the LECLERC tank, the programming center will have 5 electronics testers, 1 optronic tester and 4 workstations.

Program development will take place in 1996, 1997 and 1998.

Serial delivery of the stations will start in mid-96.

DIADEME 2 program will cover the following equipments :
- LECLERC main battle tank,
- TIGER helicopter,
- SAMANTHA, Anti-Aircraft Alert and Control system,
- VAB NBC, Armoured Vehicule for NBC detection,
- ROLAND new generation Anti-Aircraft Missile,
- VIVIANE, Thermal Imaging for Helicopter.



DIADEME 2 PROGRAM FOR LECLERC

FIGURE 6