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A NEW METHOD FOR LOW COST TESTING AND EVALUATION OF HELICOPTER COCKPITS DURING DESIGN AND DEVELOPMENT PHASES

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Abstract

The present state of the art in the helicopter industries is to test and to evaluate cockpit sections of rotary wing aircraft already during design and development phases. Experiences with former programs have shown the necessity for cockpit investigations at that early stage concerning, for instance, the influence of new avionics and flight systems or ergonomic cockpit layout.

MBB has recognized these facts and has developed an advanced flight simulation facility, consisting of a Computer Generated Image Visual System (CGIVS) and a rig for installing different cockpits, achieving valuable results. But, in order to obtain such advantages, high costs are entailed. MBB therefore plans in future to improve the simulation facility in order to obtain quick and reliable results with an acceptable financial effort. The basis for this next generation program is provided with a 6 channel projection system.

The paper first gives a presentation of the current stage of the MBB simulation program in the form of a short overview of the activities and results obtained. The main part presents the scheduled new MBB facility for testing and evaluation of modern helicopter cockpits by describing the extended digital flight simulation computer and image generator, the extended and improved visual projection system, the philosophy of the totally modular cockpit part and the influence of the above techniques with respect to cost reduction.

1. INTRODUCTION

At the present time, testing and evaluation of advanced cockpit layout is a major element of each aircraft development. Experiences, in particular with former helicopter programs, have shown that there is often a big difference between a well-considered cockpit design and its technical feasibility. Therefore it is absolutely necessary to accomplish cockpit studies at an early stage of a program in order to avoid these mistakes.

MBB recognized these problems some years ago and started to build fully functional helicopter cockpits during design and development phases. These were used for testing and evaluation in a flight simulation facility developed at MBB. In detail, this facility meets the following requirements:

- consideration of design aspects for modern helicopter cockpits such as cockpit geometry and internal layout
- consideration of ergonomic aspects
- verification of advanced cockpit technologies like new flight management systems, flight controls and avionics before prototype flight testing
- full guarantee of safety regulations
- reduction of time, work and hardware effort during flight testing

and that means, ultimately –

- reduction of costs

The following paper shows the major cost elements when testing and evaluating helicopter cockpits during design and development phases by presenting the MBB simulation technology up until today and demonstrates the impact of an advanced cockpit simulation facility on cost reduction.

2. COCKPIT SIMULATION WITH “BEAM SPLITTER” TECHNOLOGY (1ST GENERATION)

As an extension to the fixed wing simulation facility, some years ago MBB initiated a program for developing a helicopter cockpit simulator. This facility, which is shown in Fig. 1, consists of the main following elements:

- flight simulation computer
- image generator computer
- visual projection system
- control units
- fixed based helicopter cockpit
- mechanical cockpit interfaces

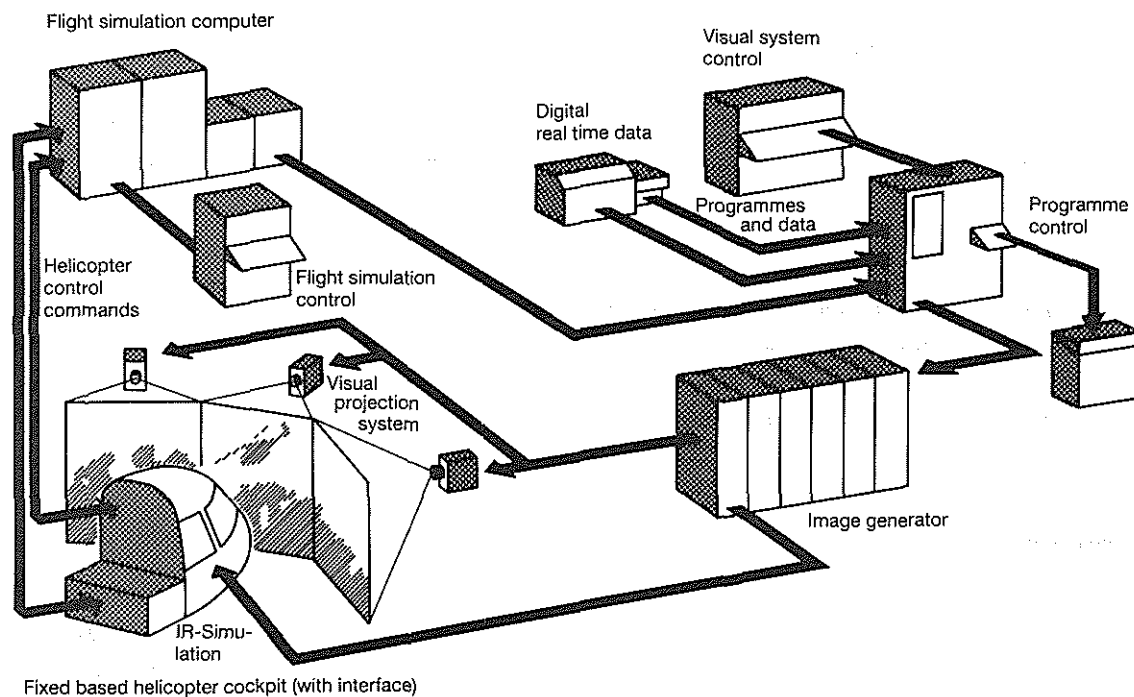


Fig. 1 “Beam Splitter” Simulation Facility with Helicopter Cockpit

Flight simulation computer, image generator computer, visual projection system and control units are systems specific to that part of the simulation facility which is independent of the cockpit type for fixed wing or rotary wing aircraft.

The flight simulation computer drives the cockpit instruments and controls and transfers the actual flight data to the image generator.

In addition, the buffet system, which simulates vertical cockpit accelerations up to ± 2 g maximum within a total frequency range of 3 to 35 Hz, is controlled by the flight simulation computer. The image generator computer provides TV-type pictures synthetically generated from a numerical description of the landscape data base, produced off-line. The projection system consists of three TV-monitors fed by the 3 video channels of the image generator. The system provides a total field of view of 106° in azimuth and $\pm 11.5^\circ$ in elevation.

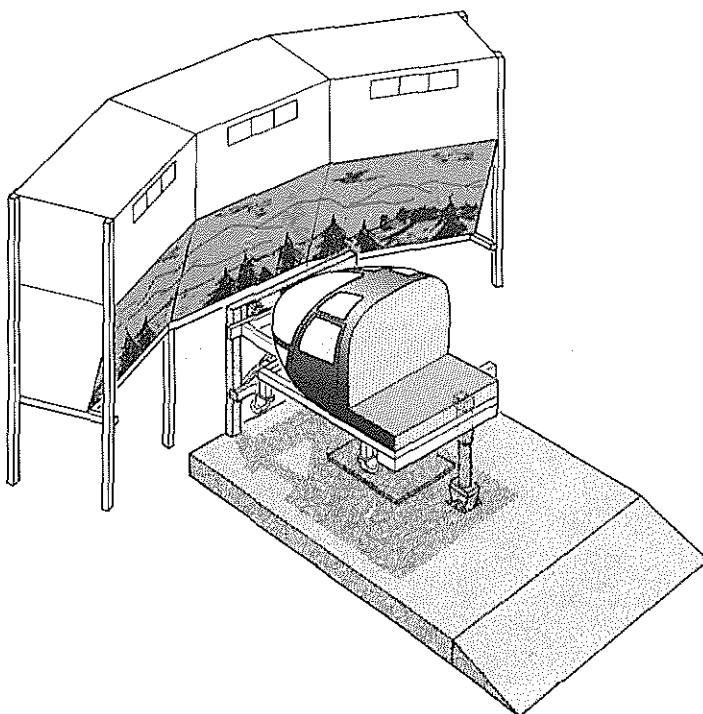
The Beam Splitter is installed in front of the interchangeable cockpit in a position where the three optical axes intersect the pilot's eyepoint. Fig. 2 shows a typical cockpit outside view.



Fig. 2 Beam Splitter Cockpit Outside View with CGI-Scene

To realize a quick change of various helicopter cockpits in the simulation facility, MBB uses special Quick Change Cockpits (QCC). That means the whole cockpit assembly, consisting of cockpit floor with controls, instrument panel, seats and canopy are mounted on a movable platform. In this version the movable platform is a comprehensive part of the QCC like the whole cockpit equipment. Therefore it is very costly to realize any changes caused by design requirements for instance.

The mechanical interface provides the positioning of the QCC on the buffet rig by three fixed points. The hydraulic cylinder, which generates the buffeting, is simultaneously the rear fixed point. The transporting of the QCC to the necessary eye point position is done by a lift. Owing to the requirement that the pilot's eyepoint has to be identical with the point of intersection of the three optical axes of the visual projection system, the suspension of the QCC is asymmetric. Because of the fact that the pilots's eye point position is normally never the same for different helicopter types, it is not possible to use one type of movable platform suspension. Fig. 3 shows the Beam Splitter facility.



Main features:

- Flight simulation computer
(incl. buffet sim.)

- Image generator computer
(output: 3 video channels)

- Visual projection system
(field of view: 106° horizontal
±11,5° vertical)

- Cockpit interface
(mech.)

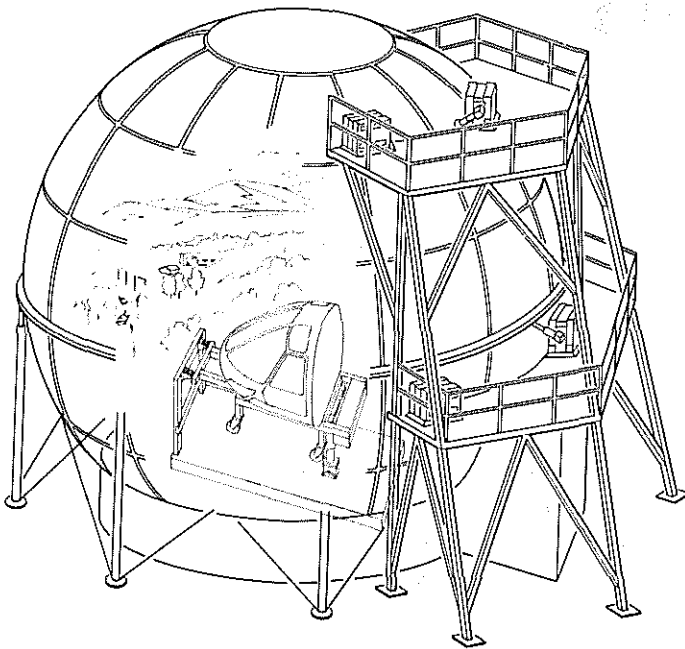
- Quick change cockpit

Fig. 3 Beam Splitter Facility

Buffet rig, mechanical interface and QCC are systems specific to the helicopter.

3. COCKPIT SIMULATION WITH “DOME” TECHNOLOGY (2nd GENERATION)

MBB is procuring a Dome simulation facility as an essential improvement to the Beam Splitter technology. The main features of this facility are a spherical dome with an extended 6 channel CGI and visual projection system feeding 6 light valve projectors working simultaneously. The resulting field of view is 140° in azimuth, +72° and -44° in elevation. In addition to the buffeting the flight simulation computer provides helicopter noise simulation.



Main features:

- Flight simulation computer
(incl. buffet & noise sim.)
- Image generator computer
(output: 6 video channels)
- Visual projection system
(field of view: 140° horizontal
+72°
-44° vertical)
- Cockpit interfaces
- Quick change cockpit

Fig. 4 Dome Facility

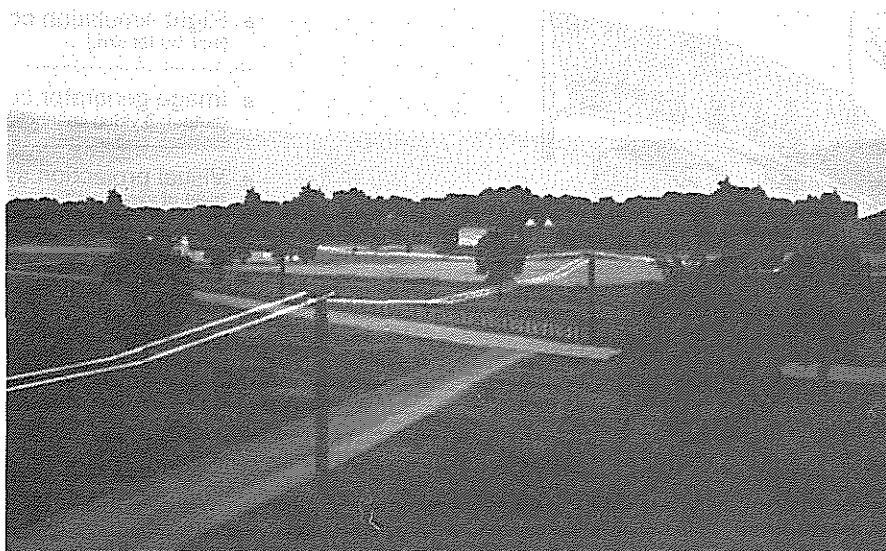


Fig. 5 CGI-Scene of Dome Facility

Together with this new visual projection system a partly modular simulation cockpit will be used. The modules, shown in Fig. 6, are

- movable platform
- floor with fixed mounted controls, instrument panel and seats
- canopy

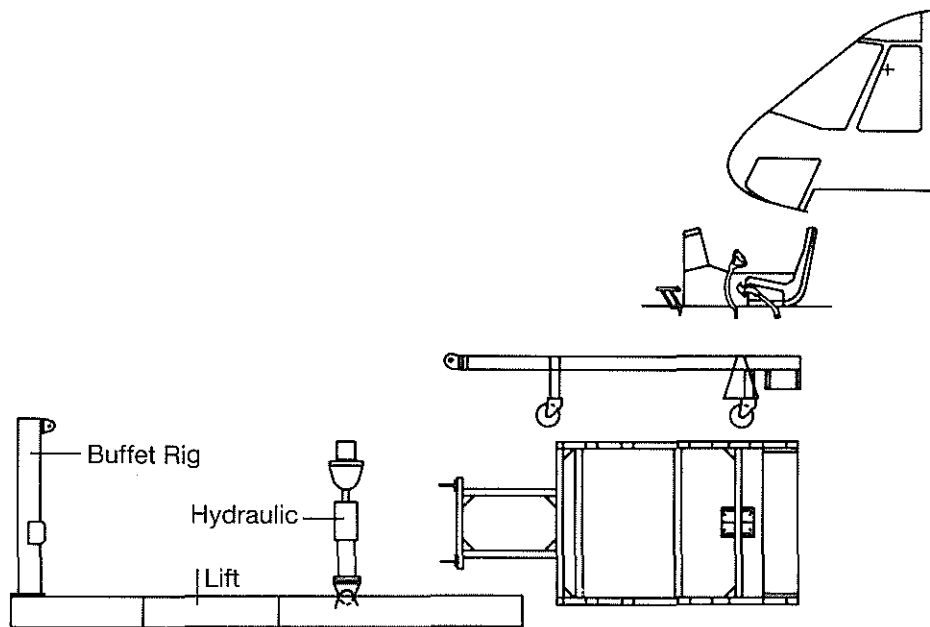


Fig. 6 Simulation Cockpit Moduls for Dome Facility

The application of the Dome technology provides the advantage that the pilot's eyepoint does not have to be exactly identical with the collimation point of the visual projection system. Therefore, there is no longer any need for an asymmetric suspension of the QCC on the buffet rig. The consequence is a uniform and more simply designed movable platform for the various cockpits. Cockpit floor with assembly and canopy are still specific to the helicopter type but, however, it is possible to modify them separately, when design changes are required.

These aspects lead to a first considerable reduction fo production and modification costs for simulation cockpits as will be shown later in this paper.

4. COCKPIT SIMULATION WITH ADVANCED DOME TECHNOLOGY (3rd GENERATION)

The advanced Dome facility consists of

- an extended flight simulation computer with buffet, noise and "g"-force simulation capacity
- an extended image generator computer with an 8 video channel output
- an extended visual projection system, which provides a field of view of 230° horizontally and +112°/-45°vertically
- (mechanical) cockpit interfaces and simulation control units
- Quick Change Cockpit (QCC)

The most important improvement of this advanced facility will be the realization of a new technology for the simulation cockpit assembly. Fig. 7 shows this fully modular assembly consisting of

- a very simplified movable platform
- cockpit floor
- core cockpit module
- canopy

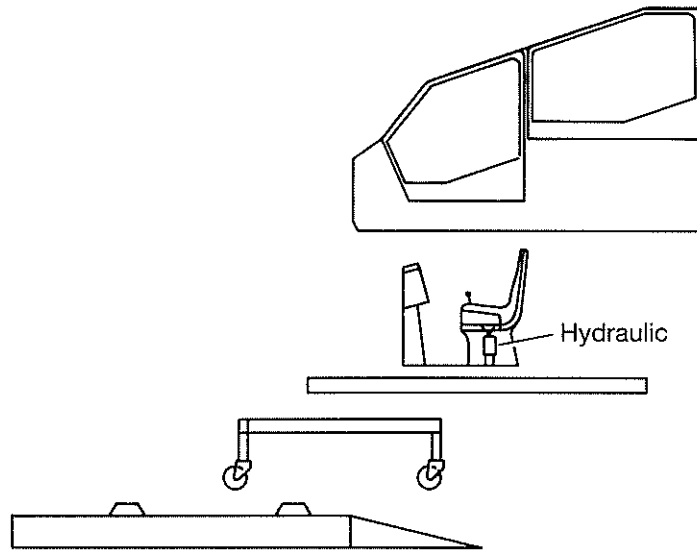
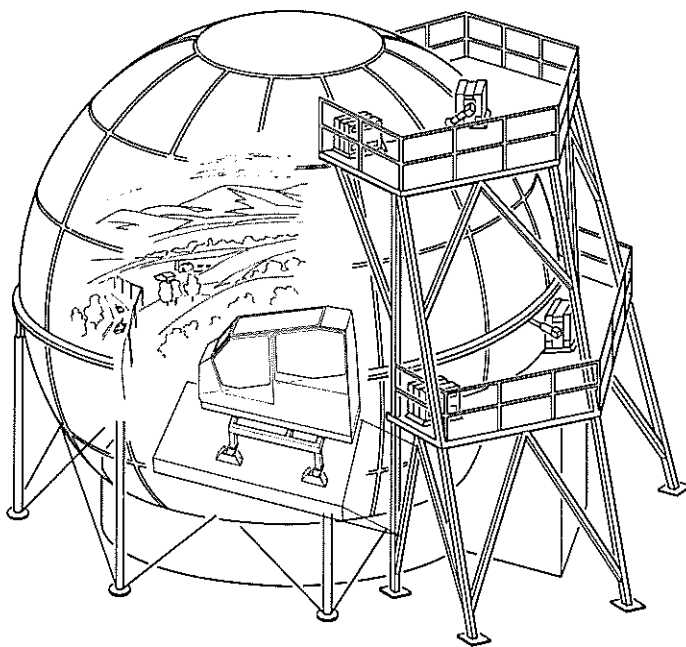


Fig. 7 Fully Modular Cockpit Assembly for Advanced Dome Simulation



Main features:

- Flight simulation computer
(incl. buffet noise "G" sim.)

- Image generator computer
(output: 8 video channels)

- Visual projection system
(field of view: 230° horizontal
+112° vertical
-45° vertical)

- Cockpit interfaces

- Quick change, fully modular cockpit

Fig. 8 Advanced Dome Facility

4.1 CORE COCKPIT MODULE

Studies of modern cockpit layout have shown an increasing correspondance in kind and number of devices even though they belong to instrument panels of helicopters with totally different missions. This trend will probably lead to a standardization of the cockpit working area. The core cockpit module is proposed as a possibility to meet this requirement. It is a compact autonomous cockpit element, which is adjustable for each mission role by integration of special display modules and application of mission specific software. It is therefore possible to install the core cockpit module in various helicopter configurations such as tandem or side-by-side cockpits.



- One core cockpit module for each helicopter type
- Role change by software input
- Buffet equipment and “g” forces simulation implemented in module
- Wide field of view

Fig. 9 Core Cockpit Module

The total seat structure is made of composite material and incorporates the hydraulics to simulate buffeting and “g”-forces impact. The lower structure of the seat ends in a footrest, which is adjustable only for comfort and has no control function at all.

Integrated in the module is the adjustable panel structure with light-weight flat panel displays.

In the left armrest is a control unit incorporated with an alphanumeric keyboard and a flat panel display. The unit is a removable device and is used for pre-flight mission data entry, for inflight data change and system control and for debriefing and post-flight checks. The right armrest carries the side arm controller including switches for engine power trim, etc.

The remaining mechanical switches will be in the center post of the panel below the primary displays.

4.2 MOVABLE PLATFORM, COCKPIT FLOOR AND CANOPY

Because of the integration of the hydraulic system into the seat structure of the core cockpit module, there is no longer any need for the buffet rig. This leads to an optimum cockpit outside view and a very simple movable platform, which is adjustable in height without any lift and suitable for each cockpit type. The wheels can be fixed at each desired position by a simple variable locking mechanism on the ground floor.

The cockpit floor is a wooden board with dimensions depending on the cockpit type.

The technique for the canopy is the same as already shown for the 2nd generation Dome facility.

The above-mentioned layout leads to a cockpit assembly which is fully modular and adjustable for each cockpit type and design. All that is needed is basic equipment consisting of two movable platforms and, at most, four core cockpit modules together with the relevant canopies and floors. With this equipment it is possible to test and evaluate two cockpits in parallel, that means one cockpit is running in the simulation facility while the second is being prepared.

In this way, it is possible to minimize the time, work and hardware effort for any new cockpit and modification.

5. COST REDUCTION

Fig. 10 and 11 give an impression of costs for production of and modification to simulation cockpits, considering the current technology of the 1st and 2nd generation. By applying this technique it is necessary to build a prototype cockpit for each helicopter and to use the same cockpit for each modification.

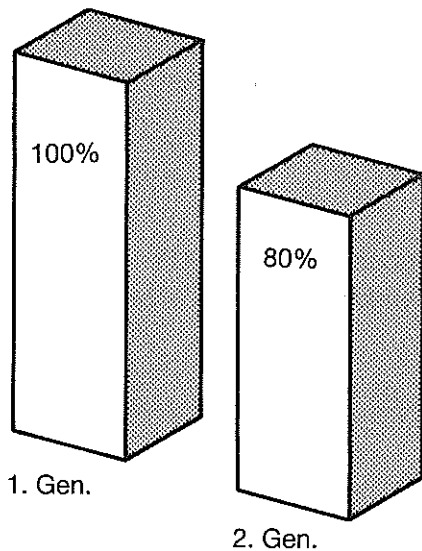


Fig. 10 Manufacturing Costs

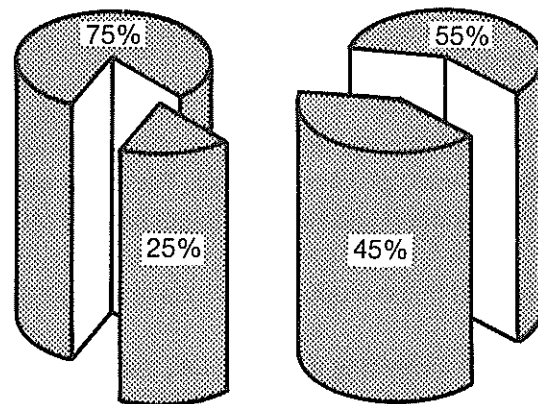


Fig. 11 Costs for Change in Design

In Fig. 10 the manufacturing costs for the 1st generation Beam Splitter cockpits are given as a 100 % standard. For the 2nd generation Dome cockpit the costs decrease to 80 %. This reduction depends mainly on the simplified movable platform owing to the symmetric suspension on the buffet rig and the partly modular layout and manufacture of the cockpit.

Fig. 12 also shows the amount of costs necessary for accomplishing a typical change in design for the first two different cockpit generations. Once again, the partly modular layout of the 2nd generation cockpit is mainly responsible for the cost reduction of 45 % as against the production of a new prototype cockpit. The costs for a 1st generation cockpit modification (75 %), on the other hand, are relatively high owing to the hardware complexity.

In spite of the fact that there is a substantial decrease in costs from the 1st to the 2nd generation of simulation cockpits, it has to be taken into account that one prototype cockpit for each helicopter always has to be built, which represents the main proportion of the costs as shown in Fig. 12.

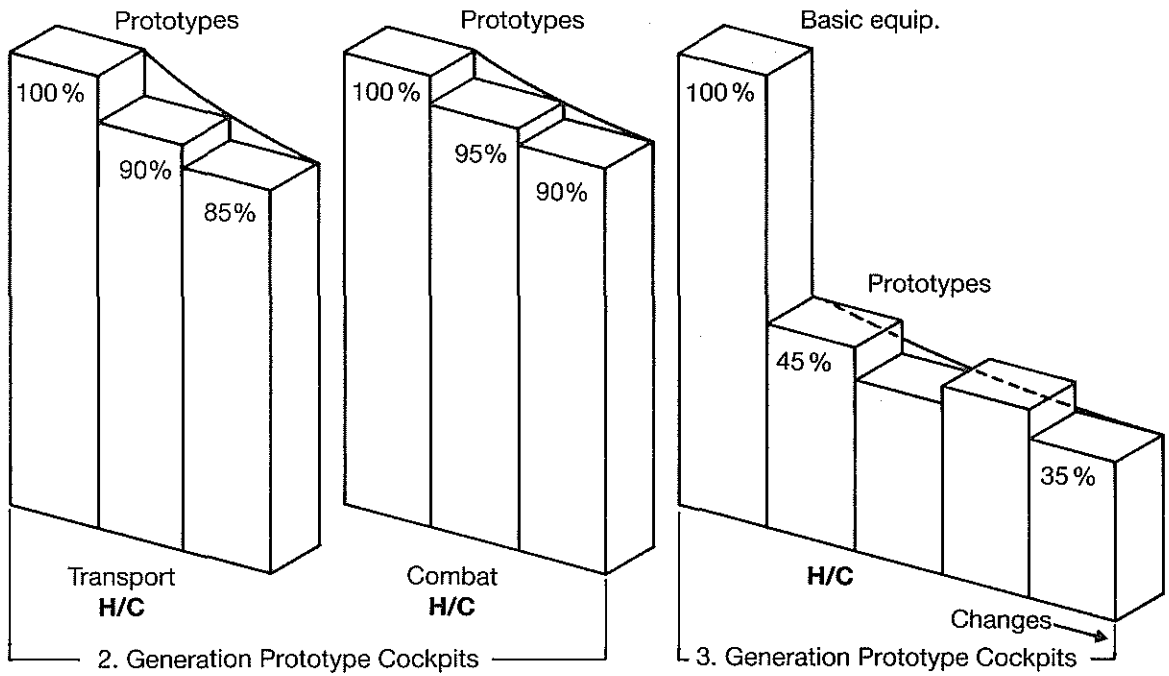


Fig. 12 Prototype Cost Reductions

The decrease in costs for producing prototype cockpits of different helicopters in the current manner depends more or less on the learning curve.

6. CONCLUSIONS

The consequence of these aspects is a fully modular cockpit technique. It provides the possibility of producing various simulation cockpits, as shown in Fig. 13, with minimum interchangeable basic equipment and it minimizes the need of new cockpit components.

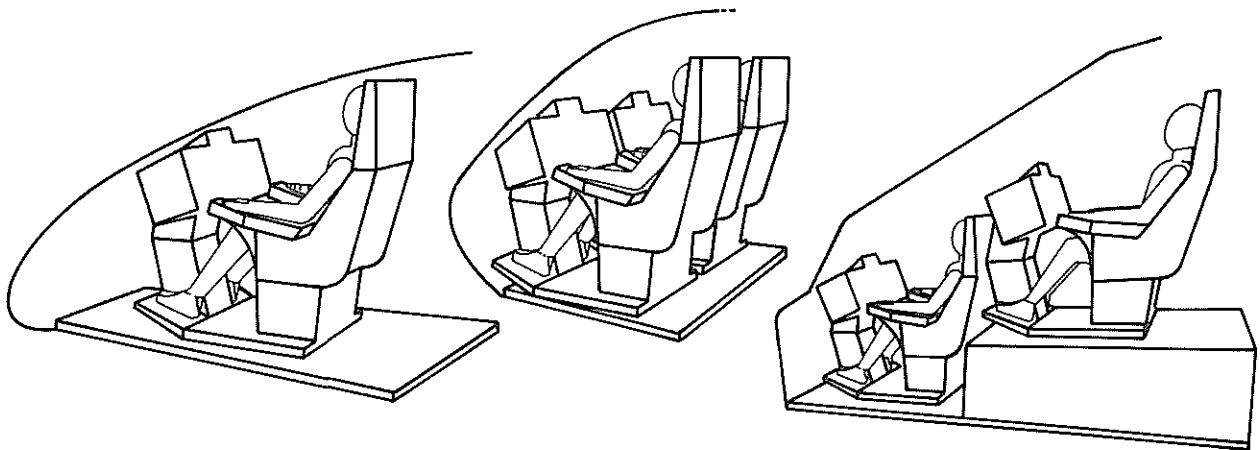


Fig. 13 Fully Modular Cockpit Technique

It is expected that the application of this technique will yield a cost reduction of about 50% as against the 2nd generation simulation cockpits (Fig. 12). Last, but not least, the cost reduction rate for modifications of the 3rd generation cockpits will be higher than that of the 2nd generation ones owing to the absolutely simplified movable platform and the fully modular layout of the simulation cockpit.

7. REFERENCES

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