TRAINING SYSTEMS ACQUISITION

SOLVING DATA ISSUES FOR FLIGHT SIMULATORS VIA THE ACQUISITION APPROACH

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ABSTRACT

Managing data for flight simulators includes not only the problem of managing the accuracy and availability of aircraft performance data, but also design data i.e. data that describes the hard and software of the prime aircraft system. This problem can be magnified if the simulators are developed concurrently with the prime aircraft. Concurrent development offers numerous benefits to the user including, for example, preparing the instructors to operate the simulators and training the initial crews properly, without resorting to expensive and inferior work-arounds whilst waiting for the simulators to be developed. However, success of concurrent development requires close coordination of the training system development with the prime aircraft development in all programme phases. An approach utilizing the prime contractor, for the prime aircraft programme, to develop the training system can significantly reduce the risks related to the management of data; particularly when the training system, with its flight and mission simulators, is developed concurrently with the prime aircraft.

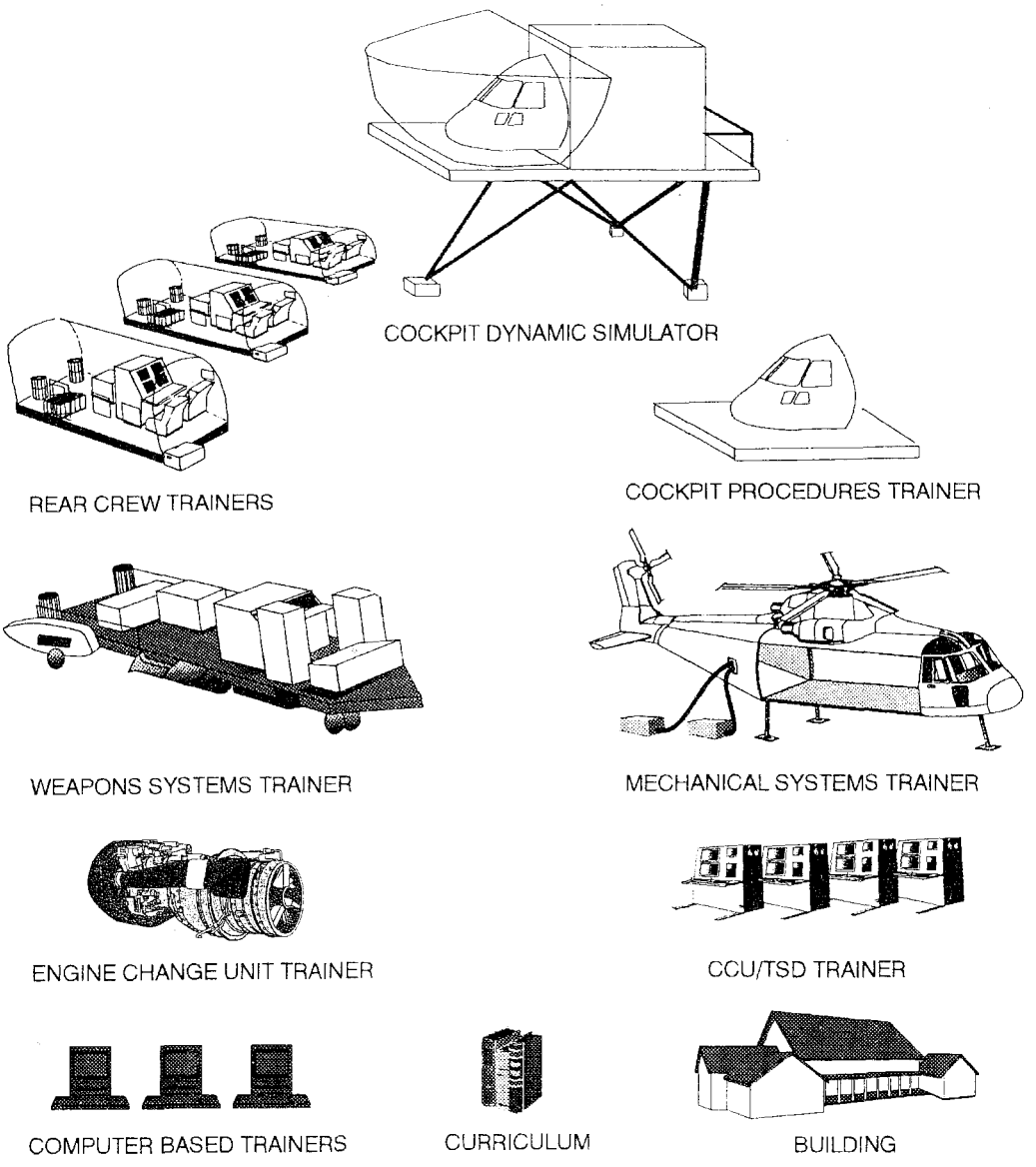

FIG. 1—MTS ELEMENTS
CCU—COMMON CONTROL UNIT TSD—TACTICAL SITUATION DISPLAY

Upon award of the MPC in October 1991, IBM established a wholly owned subsidiary IBM ASIC, (operating from its United Kingdom Headquarters at North Harbour, Portsmouth.), to manage the MPC responsibilities. These responsibilities include among other things the guarantee of system performance while assuring MoD the delivery of 44 highly sophisticated aircraft at an agreed fixed price and schedule. IBM ASIC will use its MPC role to ensure that data for all of the training devices is available to the manufacturers when required. For the remainder of this article, the focus of data management will be in the area of the flight simulator and rear-crew trainer, which will be referred to as the 'Full Mission Simulator Complex'.

Concurrent Development

The MPC will manage the development of the prime aircraft programme and weapons system, whilst concurrently developing the MTS to production aircraft standards. This requires close liaison of the prime and training system development programmes, and a management approach with simulator suppliers, that allow the full mission simulator to evolve with the maturing prime programme. To optimize simulator fidelity, trade-offs between the use of prime mission software and equipment and the development of trainer unique simulation software and equipment must be made. Often, this trade-off results in the use of prime mission soft and hardware, in areas demanding high fidelity. The problem then becomes not only one of ensuring the availability of accurate aircraft performance data, but also of the management design data. The MPC has developed the necessary plans and management approaches to ensure that this data is available to simulator manufacturers in such a way as to produce a low-risk programme for the customer and training community; whilst it assumes responsibility for and manages this risk. The MPC has the ability to resolve conflicts in data and equipment availability without having to resort to the negotiations across multiple contracts that often lead to costly delays. The data involved in simulator design and development is quite extensive. (FIG. 2) pictorially represents the database of data currently compiled for the MTS. A few of the more than 300 entries in the database are shown to highlight some of the more obvious entries such as:

- Vehicle performance data.
- Land-on ships data-including such things as ships' deck lighting and markings.
- Mission databases such as issued by the Director General Underwater Weapons (Naval) and the Royal Navy Electronic Warfare Operational Support.

Data management approaches discussed in this article include these databases.

The SEA KING Mk5 anti-submarine warfare helicopter was introduced into Royal Navy service in 1980. The Mk5 flight simulator planned 'ready for training date' was December 1985, but was delivered more than two years late. There were a number of causes for the delay, but some of the delay was directly attributable to the availability and accuracy of aircraft flight data and use of aircraft parts[1]. The MERLIN, replacing the SEA KING, has a Ready for Service (RFS) date of early 1999. By that time, the production baseline for the 44 aircraft will have been defined. Aircrew and maintainers will have been selected, and training initiated to support the staffing requirements of the programme. In order to initiate training in time to support RFS, the MTS must be ready for training in 1998 to prepare instructors and commence training the first crews. This requires the full mission simulator complex to be developed concurrently with the development of the prime aircraft. A National Audit Office report[2], describes a number of simulator programmes where late introduction of the simulators has resulted in extra costs. The report promotes the development of simulators concurrent with the parent equipment to avoid costly work-arounds. A consequence of this concurrency, however, is that aircraft flight performance and design data (data representing the form, fit and function of prime mission hard and software selected for use in the simulators), must be carefully managed to enable simulator manufacturers to proceed with simulator development, without cost and schedule impacts. An efficient method of managing this without cost and schedule ramifications to the procuring agency and precluding impact to meeting aircrew and maintainer training requirements, is to have the aircraft prime contractor assume responsibility and develop a management approach that most effectively addresses this requirement. The MPC has assumed this role on the

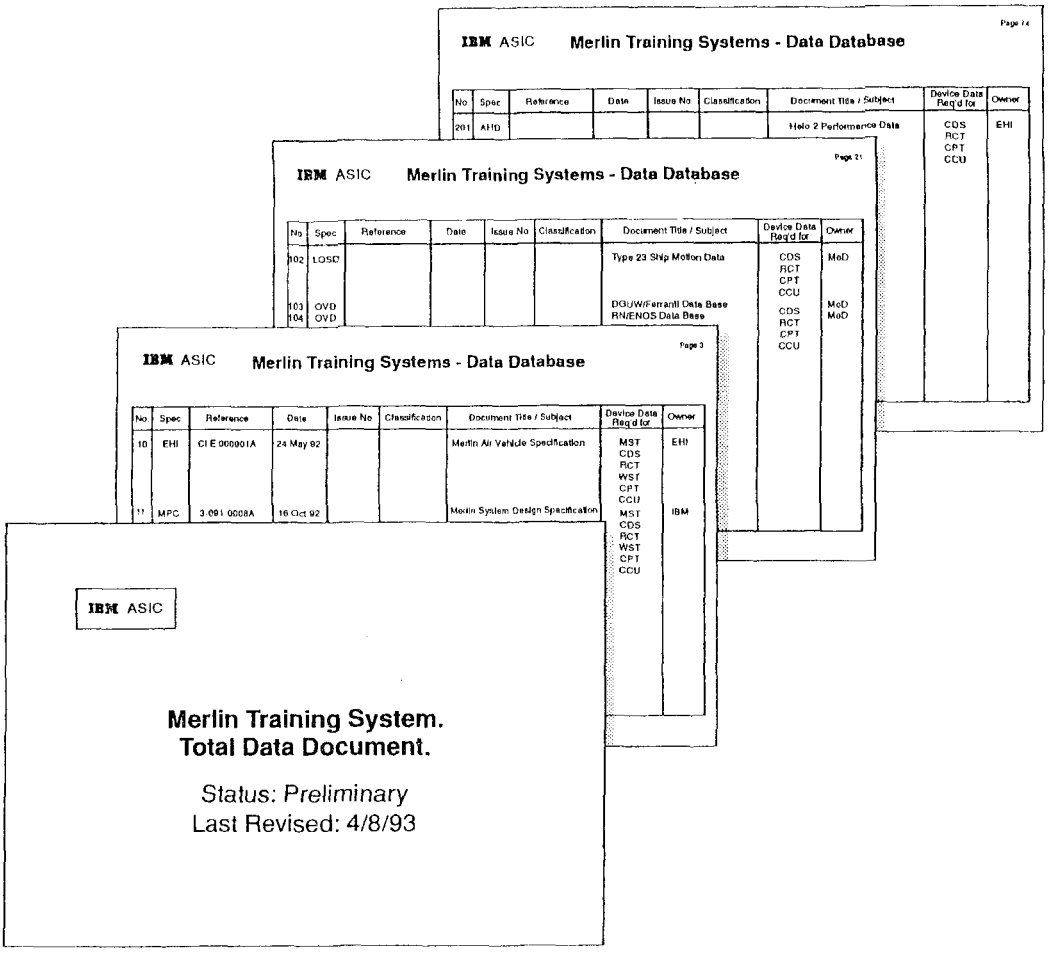

FIG. 2—MTS DATA DATABASE

MTS and is applying its programme management disciplines to help ensure successful development of the training system concurrently with its prime aircraft development responsibilities. The various disciplines that will benefit the MTS that have been established by the MPC for the prime aircraft programme include:

- Risk assessment and management.
- Configuration management.
- Contract data management.
- Systems engineering tools and methodology.
- Schedule control.
- Mission software development and management control.
- Prime aircraft hardware development and management control.
- Logistics support including support equipment.
- MERLIN Information Management System (MIMS).

The timely availability of prime hard and software chosen for use in simulators and ensuring their correct configuration, is important in successful simulator development. In addition, an effective configuration management discipline is a prime element in the successful implementation of concurrency in the training system and prime aircraft programmes. A focus on these disciplines is appropriate as they have the most impact on the management of data for simulators. The

other disciplines can positively influence the data management problem to a lesser degree.

The following sections describe these focal disciplines and management approaches being applied to the MTS programme, beginning with the tendering phase, which is in progress now and ending with a review of the plans for future development and support phases.

Management of Data

Tendering Phase

A critical time in the programme that ensures all parties are committed to the management of data is during the tendering phase. It is now that agreements can be put in place defining how data is to be managed and schemes defined for introduction of data into the programme. Plans are developed for updating the data as it matures and responsibilities can be decided. For the MTS, the potential simulator suppliers were required to provide the following major information in their responses:

1. Identification of the trade-offs in the use of aircraft mission software versus emulation of the software.
2. Identification of the trade-offs in the use of prime system hardware or commercial variants versus use of trainer-unique hardware.
3. Identification of the requirements for aircraft performance, aircraft hard and software data including content and timescales.
4. Identification of the process used to accept updates to all forms of data during the development phase of the programme as well as the post-delivery support phase.

Projected changes to the aircraft design are included in the tender documents, and bidders are instructed to document the impacts these changes would have on their selected approach. The tender evaluation process includes thorough treatment of the above responses in relation to the following parameters:

- Relative cost of implementing the changes.
- Timescale for implementation of the changes.
- Authenticity of the data requirements in relation to the technical approach.
- Timescale for data requirements.
- Implementation approach projecting the lowest through-life cost.

The above requirements focus the potential simulator suppliers to develop the most cost-effective approach in the use of stimulation versus emulation. They also ensure that the potential suppliers recognise the need for flexibility as the programme matures and changes occur throughout the system that affect simulator fidelity, whether the changes occur in the flight performance arena or in prime system hard and software function. Once the preferred supplier is selected, negotiations focus on obtaining the agreements on the timescales for which initial data must be available and when updates to this data will be incorporated into the simulator design, while ensuring cost commitments and delivery schedules are met. It is also important during this negotiation period to agree the process for incorporating upgrades to the simulators after delivery to the MERLIN training centre. The concept of 'tuning' has been used to describe the method wherein potential suppliers define the approach utilised to assure simulators maintain high fidelity whilst the aircraft programme progresses. Tuning allows continuous updating of the Full Mission Simulator Complex during the period following delivery to the training centre, whilst the production configuration of the aircraft is undergoing change resulting from post-delivery aircraft test activities.

A full mission simulator complex, consisting of flight and rear-crew simulator

suites, requires management of many common elements of data. In the MTS, it is not a requirement that the flight and rear-crew simulators be developed by a single manufacturer. It is imperative then that these common data elements be properly managed to avoid costly duplication of the data elements and that the technical challenges of synchronization of data between front-end and rear-crew simulators in full mission training mode are effectively solved.

The method chosen in MTS is the leader-follower integration requirement that the simulator manufacturers will implement. In this approach, the leader and follower suppliers are established at the time of contract award. The two suppliers, one for the flight simulator and the other for the rear-crew trainer, must agree to work together on a common set of data elements. These elements include such items as:

- Modelling and scenario generation databases.
- Sharing of operational data when in full mission mode (e.g. navigation data).
- Man-machine, interfaces (e.g. display format generation, instructor control).

The leader will have the responsibility of defining the approach, with the agreement of the follower, that will be taken to implement the common data elements whilst the follower will be responsible for implementing the selected common design approach. The leader and follower will agree on who will implement each of the elements thus ensuring only one cost-effective common design is produced and utilised. The MPC is the tie breaker on any conflicts arising from this approach. The leader is responsible for integrating the full mission trainer in its facility and ensuring that a completely integrated full mission trainer complex, with proven common data elements, is delivered to the MERLIN training centre.

Development and Support Phases

Available technology permits exceedingly increased fidelity in flight and mission simulator developments being considered today. As powerful embedded computers with significant amounts of memory are available at attractive costs, the ability to provide very high fidelity simulators that can faithfully reproduce operating environments is available to the customer. In providing this high degree of fidelity, the use of prime aircraft mission hard and software must be considered in terms of ease of upgrade of the simulator, through-life costs in maintaining this hard and software, and cost implications of moving towards full simulation approaches. (FIG. 3) indicates the typical subsystems of the MERLIN aircraft that must be evaluated for use of emulation versus stimulation.

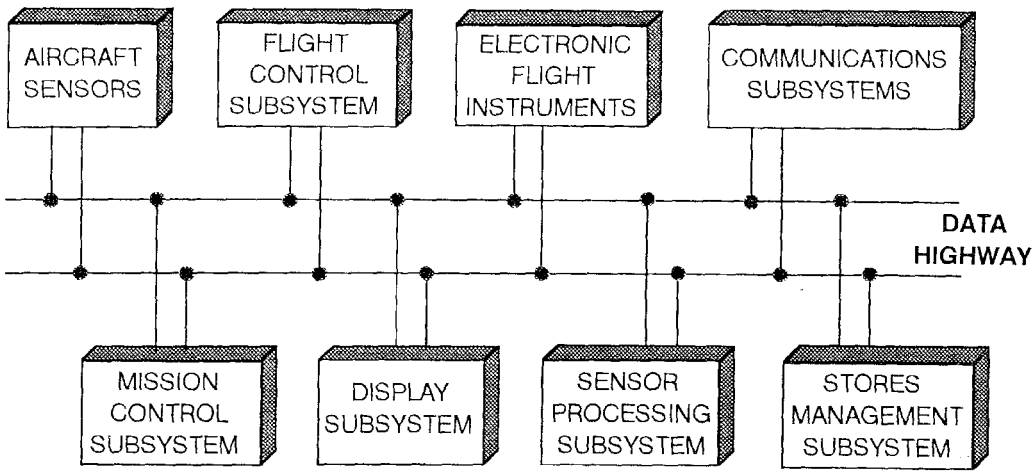

FIG. 3—MERLIN TYPICAL SYSTEM DIAGRAM

Inevitably, mission-critical components, usually in the areas of the mission computer, the flight control computer system, and the associated mission and flight control software are chosen from the prime aircraft programme. In so doing, this places an additional burden of ensuring that the soft and hardware is provided to the simulator manufacturer on schedule and at the correct configuration level.

Again, the management approach utilized by the MPC is to maintain close liaison between the prime development and the training system development programmes. Close synchronization of the two programmes allows timely transfer of data from one to the other and avoids costly schedule delays. Inevitably, conflicts arise in the need for highly critical hardware components to support both the aircraft and training programmes. The MPC can resolve these conflicts whilst meeting the commitments of both programmes. Frequently this requires timely decisions regarding the resolution of these conflicts that often is made extremely difficult when separate contract structures are in place for what are often multiple procurement programmes.

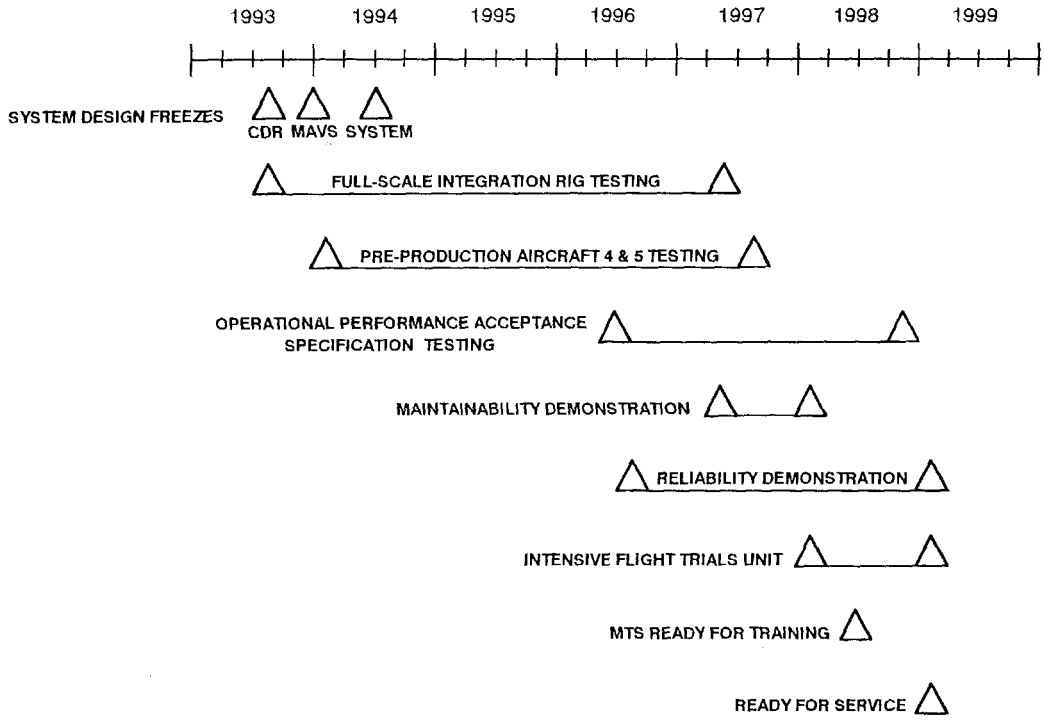

FIG. 4—MERLIN PROGRAMME SUMMARY TEST AND INTEGRATION MILESTONES
CDR —CRITICAL DESIGN REVIEW MAVS—MERLIN AVIONICS SUBSYSTEM

The major milestones of the MERLIN programme are depicted in (FIG. 4). The significant milestones relating to aircraft data volatility occur during the conduct of the various test programmes. It is during these periods of time in the programme where timely and accurate data is being gathered for use in the full mission simulator complex. The leader-follower approach described earlier will be instrumental in assuring the management of data during the development of the sophisticated full mission simulator complex results in a minimal set of elements to be controlled and updated over time.

(FIG. 5) shows the programme milestones for providing data to the MERLIN simulator manufacturers. As shown, data is made available early in the test programme to enable the simulator manufacturers to begin development of the simulators. As discussed earlier, the manufacturers are required to develop the simulator in such a way that changes to this data can be accommodated in the

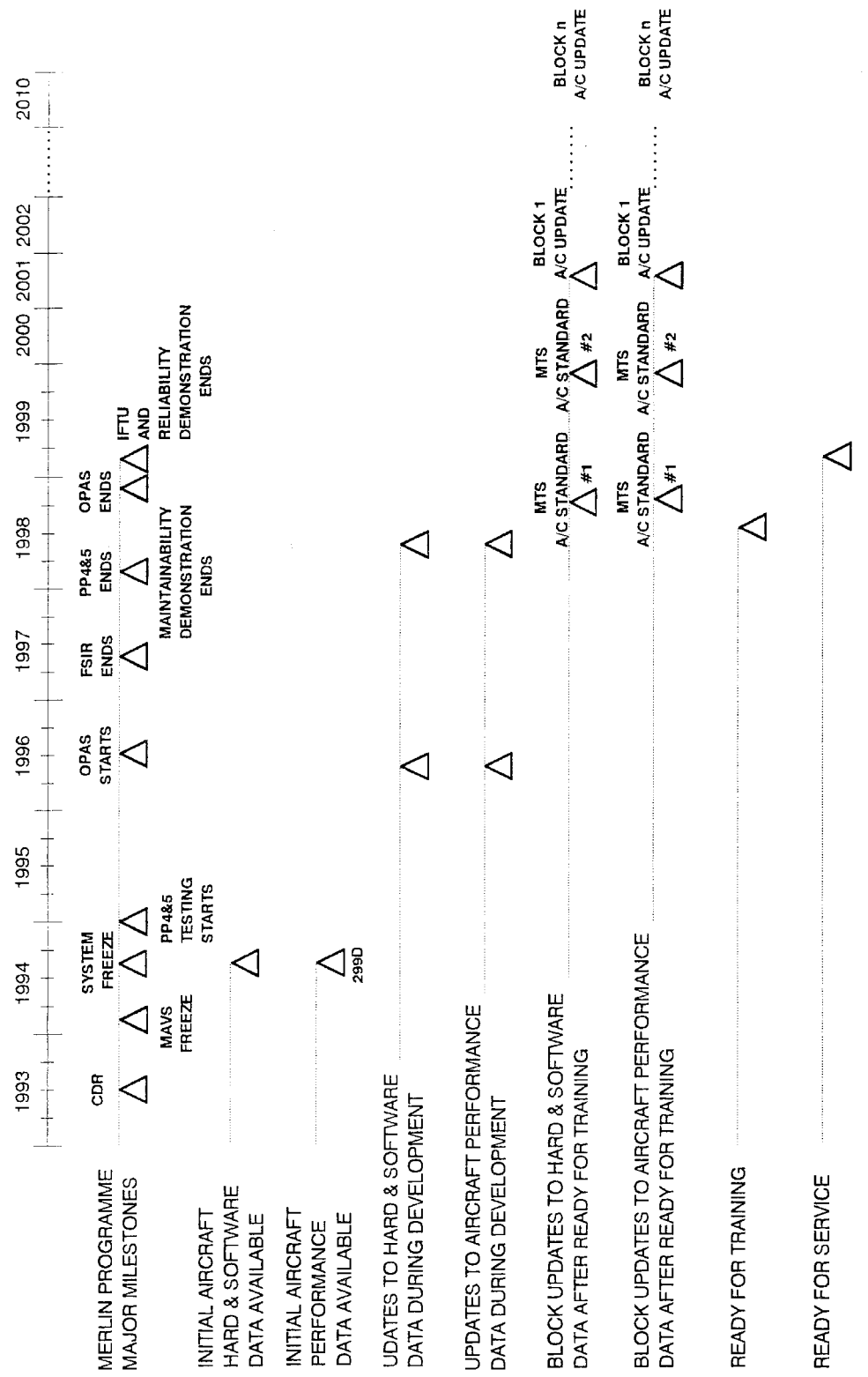

FIG. 5—MTS AIRCRAFT DATA MILESTONES

CDR —CRITICAL DESIGN REVIEW
MAVS—MERLIN AVIONICS SUBSYSTEM
OPAS —OPERATIONAL PERFORMANCE ACCEPTANCE SPECIFICATION
FSIR —FULL-SCALE INTEGRATION RIG
PP —PRE-PRODUCTION AIRCRAFT

design without cost and schedule implications. As the data matures, the simulator manufacturers accommodate the data at pre-planned milestones selected to permit the updating of data while maintaining programme integrity. A further planned upgrade occurs after delivery of the simulator to the MERLIN training centre to accommodate any changes to the MERLIN helicopter production configuration resulting from the conduct of all test programmes.

This activity, shown in FIG. 5, occurs after completion of the prime aircraft test programme as depicted in the figure. Planned upgrades to the MTS over time are coordinated with the aircraft programme, utilizing the configuration management system employed by the MPC, shown in (FIG. 6). This configuration management system requires all aircraft changes to be evaluated, not only for their impact to the MERLIN helicopter, but also for impacts to the support infrastructure, including the MTS. In this manner, a change is approved for incorporation in the system with all the impacts agreed and an integrated schedule developed for upgrading the aircraft and the training system. Usually, these changes can be best accommodated in the aircraft and in the training system in pre-planned block updates as depicted in FIG. 5. These block updates would accommodate all approved changes to-date and are usually implemented in short time periods with pre-planning to ensure that the training system and aircraft remain in step.

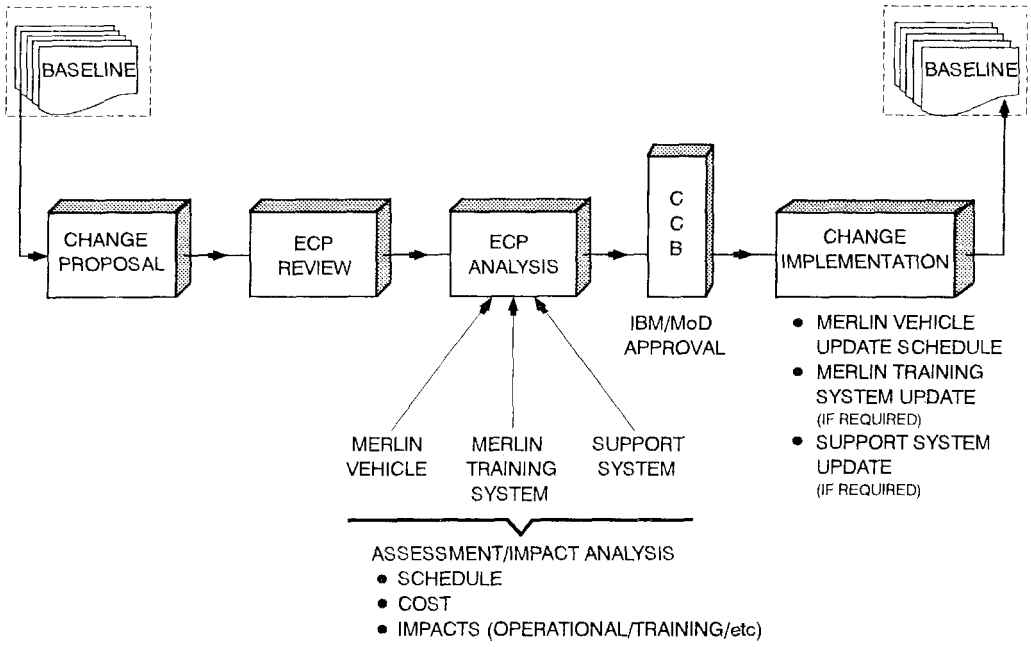

FIG. 6—MERLIN CONFIGURATION MANAGEMENT PROCESS

Because attention has been given to flexibility in the simulators in the front-end, these upgrades can usually be easily accommodated and implemented concurrently with the upgrades to the aircraft. Even changes in the types of sensors, display types or performance characteristics, can usually be easily accommodated. Of course, major system upgrades such as the installation of a new subsystem or the replacement of an existing system that add new man-machine interfaces to the prime aircraft would be more difficult to implement in the simulators.

Conclusion

The process of effective management of concurrent development of simulators begins by requiring the prime aircraft programme to manage the data issues and programme risks. The prime contractor must ensure the simulator manufacturers accept responsibility early on for implementing flexible architectures able to accommodate changes in data over time and to implement common approaches to shared data elements. The process is further enhanced with the selection of a well-balanced emulation/stimulation architecture utilizing a cost-effective suite of prime hard and software that will permit ease of maintaining commonality. With implementation of the leader-follower concept to manage and minimize common data elements, along with an effective configuration management programme which is part of a larger set of tools and methodologies in place and available for application to the training system programme, the MPC can ensure the Full Mission Simulator Complex can be maintained current with the system it is intended to represent. In addition, throughout the development programme, Royal Navy FSLO and SME personnel are actively involved in assessing the development programme and, when delivered, the simulator performance to ensure the data representing aircraft performance is producing a simulator that 'flies like a MERLIN'.

References

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2. 'Ministry of Defence: Use of Simulators in Training', *National Audit Office report Number HC 247*, dated 6 November 1992.