RESOURCE SIMULATOR FOR AN F-4E AIR FORCE TRAINING SQUADRON

A. J. Parker,[1] Timothy I. Chen[2]

and John Duncan[3]

[1]Florida International University

[2]Burroughs Corporation

[3]University of Miami

Within the United States Air Force exist various Tactical Fighter Wings. The mission of the Wing simulated in the model is twofold: (1) Training of airmen for combat and (2) Maintaining a combat ready status. In the model the Wing consists of three squadrons, with a total of fifty-six F-4E fighter aircraft. Two of the squadrons are used for fighter training and the third is on combat ready status.

In order to train a fighter pilot, the Air Force provides a training syllabus that covers a period of half a year. Within this period, seventeen different types of sorties are specified. A sortie consists of a take off, flying time, and a landing. For the two training squadrons, the classes are staggered by three months so that classes graduate every three months.

A major difficulty at the Wing level is the scheduling of spare aircraft to replace those that are not air-worthy. Failures of systems in the F-4E are substantially higher than those in aircraft used for commercial aviation. One of the goals of the simulation is to determine the number of spare aircraft needed to fulfill the training mission, based on the failure rates.

From a tactical point of view, the model will give detailed information regarding the day to day operation of the Wing. Such measures as the number of operational aircraft and the number in maintenance are given as well as the summary of flight time and time in scheduled and unscheduled maintenance.

Strategically, the model will provide information on (1) scheduled spare aircraft, (2) the distribution of spare aircraft requirements as a function of the type of sortie, and (3) whether the Wing has the ability to fulfill the syllabus requirements with the current aircraft complement.

The model is a stochastic, variable time incremental simulation. It is initialized with the following data:

1. The number of aircraft and initial status of each aircraft; airframe and engine flight time, etc.
2. The conditional cumulative frequence distribution of WUC's (Work Unit Codes used to identify individual systems on the F-4E) for each type of failure, and the conditional cumulative frequency distribution of "Time to Repair" for each WUC, and conditional frequency distribution of multiple system failures.
3. Air, Ground, and Inspection Failure Rates (Aborts).
4. Conditional distribution of WUC's required to fly a particular sortie--the systems that are required for a mission to be flown.
5. The six month syllabus for the scheduling of the aircraft.

The syllabus specifies how many flights are required per day, what type of mission will be flown, and how many aircraft must take off and participate in an exercise together. Along with the syllabus is a table giving the daily "windows" during which flights can take off. Each squadron, in general, has two windows per day--one in the morning and one in the evening.

After initialization, the model schedules weekly activites for all aircraft. Besides flying time, there are requirements for periodic maintenance on the airframe, engines, and component systems as well as other miscellaneous requirements. Engine inspections are performed every six hundred flying hours. The airframe and component systems are examined in what are called 'phase inspections'. There are six different phase inspections staggered so that one must be performed every seventy-five hours. Besides maintenance there are other requirements for aircraft time, such as ground crew training, minor repairs, and washing.

Two main matrices are used in the model. The first is the Schedule Array. It provides the weekly schedule for the Wing. The schedule consists of a list of events with starting and ending times for each aircraft. This array is generated by the Aircraft Scheduling Algorithm.

The Plane Status Array is the heart of the model. This array contains all of the information needed concerning the current status of each aircraft in the Wing. The array gives information regarding flight hours remaining for all periodic requirements, as well as the current state, end of state time (EOST), and the future state of each aircraft. This array was initialized with data from the flight operations of the Wing at the beginning of January 1972.

If aborts (breakdowns) did not occur, the model would be complete. However, since the model does include these stochastic elements, it is important that they be clearly understood.

The occurrence of an abort is a stochastic event. In the model it is determined by using the probability of the occurrence of each type of abort and a Random Number Generator (RNG). Three distinct types of aborts are considered by the model. They are:

1. Abort while airborne--Air Abort
2. Abort just prior to take-off--Ground Abort, and
3. Abort during either a Thru-Flight Inspection or a Post-Flight Inspection--Inspection Abort.

Once an abort has occurred, and the type of abort is known, the number of system failures is determined. Both ground and inspection aborts are allowed multiple failures of up to four systems; the air abort is allowed only one.

Given the number of failures, the Work Unit Codes for these failures are determined by using one of three different conditional distributions (one for each type of abort) to determine the WUC(s) of the faulty system(s). The WUC(s) are then used in conjunction with another conditional distribution of WUC's versus Time to Repair. Once a repair time is determined for each WUC, the longest time to repair is chosen as the repair time. It is assumed that work to repair multiple failures can be performed simultaneously, and that a sufficient inventory of replacement parts exist.

The WUC's are finally compared to a list of mission types versus critical WUC's for that mission. Therefore, knowing the sortie the aircraft is scheduled to fly, the systems required for the successful completion of mission can be compared to the WUC(s) that caused the abort. If nothing critical has failed, the unscheduled maintenance is postponed until after the aircraft has completed the sortie.

Once it has been determined whether the aircraft will enter unscheduled maintenance immediately or after completion of the sortie, the unscheduled maintenance is entered in the Schedule Matrix. Whenever a critical system has failed, a spare aircraft is substituted and the aborted aircraft enters maintenance immediately. When this latter event occurs so as to change the schedule of an aircraft, suitable changes are made in the Schedule Array.

To select the proper scheduled spare aircraft to replace the aborted aircraft, several criteria must be met:

1. Is it of the proper configuration, and
2. Is it scheduled as a spare during the time of the sortie.

If these conditions are satisfied, the scheduled spare aircraft is assigned to the sortie. The Schedule Array is then changed for the spare, indicating the take-off time, the landing time, and the state. The aborted aircraft's schedule is checked for any additional flights during the day which it will not be able to fly. If any exist, these are also entered in the spare aircraft's schedule.

The above process is repeated on a weekly basis and statistics are compiled. At the end of simulated time, summary statistics are computed.