Chapter Two

# DEVELOPING AN OPTIMIZATION MODEL FOR ANALYZING INTEGRATION OPTIONS

We built an optimization model to help analyze the various options. Below we briefly discuss what that model does in each of the three options we considered, the database used for the modeling, and the model's underlying assumptions.

## HOW THE OPTIMIZATION MODEL WORKS

We developed a linear programming model designed to determine the least-cost assignment of students to schools under a variety of options by minimizing a subset of the total cost of providing training.[1] The costs included in the objective function are altered for the different options we examined. In the first option (termed "nearest school"), we changed only the *location* where a student receives training, holding fixed (at fiscal year 1996 levels) the schools and the courses offered at each school. Thus, in this option, the model minimizes the total travel cost, which is valued at 30 cents a mile.

In the second option (termed "reassign courses"), we allow *courses* to be "optimally" assigned to schools. In this case, the model's objective function includes both travel cost and annual fixed course cost.[2]

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[1]A more thorough technical description of the model is provided in Appendix A.

[2]We break course costs into a fixed component, independent of the number of students taking the course at a specific school, and a variable component based on the student load. We specifically consider only the fixed component, assuming the variable component is similar across all AC and RC schools. Since we force all students to be assigned to a specific school, there is no change in the total variable course costs across all schools.

The annual fixed course cost—which we estimate at $50,000 based on our earlier research[3]—accounts for any instructor training or other "startup" costs necessary for a school to conduct a course. This fixed cost to offer a course drives the solution from multiple training locations with small class sizes (multifunctional) to a fewer number of locations with greater numbers of students (specialized).

In the third option (termed "consolidate schools"), we examined the *number of schools* that offer maintenance-related training. In this case, we add to the objective function a fixed cost for having a school open—$370,000, again drawn from data collected in our prototype assessment[4]—which is, in turn, added to the travel and fixed course costs. Similar to course costs, we only consider the annual fixed costs of having a school open. This "open the door" cost includes administrative staff personnel, utilities, and annual facility maintenance costs.

Given the different objective functions in the three options, the model minimizes the training costs while ensuring that every soldier who was trained in fiscal year 1996 is assigned to a training location (which may be different from the school he or she attended in fiscal year 1996) and that the student throughputs—the maximum annual number of students who can be assigned—of the school are not exceeded. The throughput for a school is based on its complement of facilities, instructors, and equipment.

Finally, the model has constraints related to the minimum number of students assigned to a school in each course. As we discuss in the next section, we looked at two situations. In the first case, we allow "multifunctional" schools that can teach a wide range of courses within their branch of certification. We require at least five students to offer a course. As would be expected, this case results in a number of locations teaching courses with a small number of students.

In the second case, we create "specialized" schools that offer a limited number of courses within their branch of certification. Here, we

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[3]See Shanley et al. (1997) for a discussion of how this $50,000 cost was derived.

[4]See Shanley et al. (1997) for a discussion of how this $370,000 cost was derived. Similar to course costs, we only consider the annual fixed costs of having a school open.

add a constraint that requires at least 50 students in a grouping of related courses (e.g., wheeled or track courses) before a school will offer courses in that area. Here, courses are offered at fewer locations and schools offer a narrower range of courses.

## MODEL DATABASE

In conducting the analyses, we consider all the AC and RC students who received training in fiscal year 1996 in NCO Education System (NCOES), MOS reclassification, and other maintenance-related courses (excluding initial entry training (IET) and advanced individual training (AIT)). Table 2.1 shows the number of AC and RC courses in the various areas that we analyzed.

Records from the Army Training Requirements and Resources System (ATRRS) show approximately 5,800 AC soldiers and 8,200 RC soldiers in this data set. A number of these records were missing data (primarily, the student's home origin) we needed for our analyses and, thus, had to be removed. We were left with 3,468 AC and 6,814 RC soldier records for our analysis.

## MODEL ASSUMPTIONS

In using the model to conduct the analysis, we made two basic assumptions. First, as mentioned previously, we consider AC and RC courses as they were configured in fiscal year 1996. Thus, we assume an AC school can teach an RC version of any AC course that it offered

**Table 2.1**

**Number of Maintenance-Related Courses**

| Type of Course | AC | RC |
|---|---|---|
| MOS reclassification | 23 | 27 |
| ANCOC | 2 | 10 |
| BNCOC | 15 | 12 |
| ASI | 5 | 4 |
| Other[a] | 0 | 11 |

[a]Other includes sustainment, functional, and new equipment training.

in fiscal year 1996 and that RTS-Ms can teach AC versions of any RC course they offered in fiscal year 1996. For example, if an RTS-M offered an RC MOS reclassification course for 63B, we assume it could teach an AC version of the course.

The second assumption really deals with the type of model we are using. We are considering only the assignment of students to schools and not the scheduling aspects of the problem. Therefore, we make the assumption that a student who attended a course in fiscal year 1996 at a certain time and location could attend the course at any other time and location. This assumption would have little impact on AC soldiers who may be reassigned to other training locations, since they can attend training at any time. But it might have more of an effect on RC soldiers, although this could be mitigated if courses were offered on a regular basis at the nearby AC school, where most of these soldiers would be reassigned.

The objective of these exploratory analyses is to understand the feasibility and potential benefits of further integrating AC and RC training resources. As such, our initial assumptions are simplified and not necessarily complete. For actual policy use, the analytic model would need to be enhanced and the factors estimated in more detail.