

Streamlining Cost Estimation for Large Department of Defense Organizations

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Preface

Manpower decisionmakers need to be able to produce consistent and repeatable cost estimates to understand the budget implications of alternative total force mixes. For this study, we created a prototype tool that uses data from the Office of the Secretary of Defense Full Cost of Manpower (FCoM) model, which includes cost factors, such as compensation, health care, recruiting, and training. The prototype tool expands on FCoM by creating a method to streamline cost estimation for large U.S. Department of Defense (DoD) organizations, providing summary output in the form of graphs and tables, and allowing the user to run various scenarios in which billet counts are changed and the effect on cost can be observed.

In this report, we describe the prototype tool and demonstrate its utility on a hypothetical organization to show how it could be used when determining costs for a real organization. Although it is still only a prototype, and therefore not available for distribution, with additional development, this tool would be useful for DoD and service personnel involved in manpower policy and decisionmaking and the broader DoD research community. We close with a discussion of ways this prototype tool can be developed further and how it might be distributed to maximize accessibility.

The research reported here was completed in January 2021 and underwent security review with the sponsor and the Defense Office of Prepublication and Security Review before public release.

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Summary

As underscored in the fiscal year 2018 National Defense Strategy, budget discipline and affordability are a high priority for the U.S. Department of Defense (DoD). Considerable scrutiny is given to the rationalization of the *total force*—the mix of active duty, reserve duty, civilian, and contractor personnel employed by DoD. In particular, manpower decisionmakers need to produce consistent and repeatable cost estimates to understand the budget implications of alternative total force mixes.

For this study, we created a prototype tool that aims to help decisionmakers do just that. The prototype tool uses data from the Full Cost of Manpower (FCoM) model created by the Office of Cost Assessment and Program Evaluation within the Office of the Secretary of Defense. FCoM is a means to estimate manpower costs consistently across DoD, including compensation, health care, recruiting, and training. Although FCoM is simple to use, it requires the user to input billets manually, which is time-consuming when developing cost estimates for a large DoD organization.

A recent RAND Corporation report used FCoM data to estimate the costs associated with general and flag officer billets (Knapp et al., 2020). To streamline the calculations, the study team developed computer code that applies FCoM cost factors to an entire billet file. For this study, we leveraged that computer code and build it into a prototype tool that can be made available to the larger audience of FCoM users.

The prototype tool builds on the strength of FCoM in three ways. As discussed already, the prototype tool streamlines cost estimation for large DoD organizations, starting from a billet file instead of billets entered one by one. The prototype tool summarizes the costs in graphs and tables, while also allowing the user to download the billet file with the cost factors applied. Finally, the user can run various scenarios using the prototype tool, estimating the costs for different billet arrangements either by manipulating billet counts within the prototype tool itself or by running a modified billet file through the tool. Regardless of the method, users can easily see the effect on cost.

In this report, we describe the prototype tool and demonstrate its utility on a hypothetical organization to show how it could be used when estimating costs for a real organization. Although still in prototype form and therefore not yet available for distribution, with additional development, this tool would be useful for DoD and service personnel involved in manpower policy and decisionmaking and the broader DoD research community. We close with a discussion of the ways that this prototype tool can be developed further and might be distributed to maximize accessibility.

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Abbreviations

CAC	Common Access Card
CAPE	Office of Cost Assessment and Program Evaluation
CONUS	continental United States
DMDC	Defense Manpower Data Center
DoD	U.S. Department of Defense
FCoM	Full Cost of Manpower
FY	fiscal year
GG	Defense Civilian Intelligence Personnel System pay schedule
GS	general schedule
OCONUS	outside the continental United States
OSD	Office of the Secretary of Defense
PKI	Public Key Infrastructure
SES	Senior Executive Service
UIC	unit identification code

1. Introduction

As stated in the fiscal year (FY) 2018 National Defense Strategy, the U.S. Department of Defense (DoD) recognizes the importance of budget discipline and affordability (DoD, 2018). In particular, the *total force* mix (i.e., the combination of active duty, reserve duty, civilian, and contractor personnel employed by DoD) is the subject of much debate. To inform total force mix discussions, decisionmakers need to be able to produce consistent and repeatable manpower cost estimates. For this study, we created a prototype tool that is designed to produce those estimates in a streamlined and flexible way that facilitates running alternative manning scenarios.

The prototype tool uses cost factors provided by the Full Cost of Manpower (FCoM) model, including compensation, health care, recruiting, and training. FCoM is hosted on a website, accessible to users with a Common Access Card (CAC) or Public Key Infrastructure (PKI) (FCoM, undated). Using FCoM is straightforward. To begin, a user constructs the organization by adding billets with the following attributes: service, pay grade, expected years of service of personnel filling the billets, location, and occupation. When all billets have been added to the organization, FCoM applies cost factors and estimates the full cost to each service component, to DoD, and to the federal government.

Although FCoM is simple to use, it can be time-consuming—especially for estimating the costs for a large DoD organization—because FCoM requires the user to input billets manually. This issue was addressed in recent RAND Corporation research that used FCoM data to estimate the costs associated with general and flag officer billets (Knapp et al., 2020); the team developed computer code that applies FCoM cost factors to an entire billet file. In this report, we use that computer code and build it into the prototype tool so that this innovation can be shared with other FCoM users.

The prototype tool builds on the strength of FCoM in three key ways. First, the prototype tool streamlines cost estimation for large DoD organizations by allowing the user to upload a billet file instead of entering billets one by one. Second, the prototype tool provides the user with a summary of the cost output in the form of graphs and tables, in addition to allowing the user to download the individual-level billet file with the cost factors applied. Third, the prototype tool allows the user to manipulate billet counts in the prototype tool itself and easily observe the effect on cost.

For DoD and service personnel involved in manpower policy and decisionmaking and the broader DoD research community, a tool of this sort will be widely applicable. More specifically, this tool is ideal for performing recurring and detailed cost analyses and running various manpower policy and budgeting scenarios. Possible scenarios could include the following:

- How does a change in manpower mix affect an organization's manpower bill?
- When the mission (and therefore the manning requirement) changes, how do manpower costs change?
- How much will it cost to man a new unit? How much does the location of the new unit affect cost?

Because the prototype tool leverages FCoM cost factors, which are consistent across the services, the prototype tool is equally useful for service-specific and cross-service manpower cost estimation.

In this report, we describe the prototype tool's functionality and demonstrate the prototype tool's utility on a hypothetical organization to show how it could be used when estimating costs for a real organization. Given that this tool is a prototype and, in particular, the fact that it has only been tested on a hypothetical billet file, it is not yet available for distribution. With additional development, our intent is to make it available for use by an outside audience. Therefore, we conclude with a discussion of next steps for (1) further development and distribution of the prototype tool and (2) follow-on research opportunities in the area of manpower cost modeling.

2. Prototype Tool

In this chapter we describe the prototype tool’s capabilities. First, we discuss the FCoM cost factors that are used in the prototype tool. Second, we demonstrate the prototype tool’s utility by estimating the cost of a hypothetical organization. For a detailed, step-by-step description of how to use the prototype tool, see Appendix A.

Full Cost of Manpower Cost Factors

FCoM is a model developed by the Office of Cost Assessment and Program Evaluation (CAPE) within the Office of the Secretary of Defense (OSD) to provide annual cost estimates for individual active duty and civilian billets. To estimate the cost of a specific billet, FCoM users must enter the service, pay grade, expected years of service of personnel filling the billets, location, and occupation associated with each billet. FCoM includes costs (e.g., basic pay, cost-of-living allowances, health care, child care, and training) in its billet estimates. The cost factors that are applied to each billet vary by whether the billet is active duty or civilian and whether it is in the continental United States (CONUS) or outside the continental United States (OCONUS). The specific amount for each cost factor will vary according to other variables, such as service, pay grade, expected years of service of personnel filling the billets (or expected pay step for general schedule [GS] civilians), and location. Table 2.1 lists these cost factors and indicates whether they apply for each type of billet—active duty CONUS, active duty OCONUS, civilian CONUS, and civilian OCONUS.¹

¹ We note that FCoM does not include a factor that covers the cost of personnel management of these workforces, which could be addressed in a follow-on effort.

Table 2.1. Annual Cost Factors Applied in the Full Cost of Manpower Model

Cost Type	Active Duty CONUS	Active Duty OCONUS	Civilian CONUS	Civilian OCONUS
Basic allowance for housing	X			
Basic allowance for subsistence	X	X		
Basic pay	X	X	X	X
Child development (day care facilities)	X	X		
Child education (impact aid)	X	X		
Civilian recruiting			X	X
Discount groceries	X	X		
DoD education activity and family assistance (employee assistance program)	X	X		
Education assistance	X	X		
Fringe benefits			X	X
Hardship differential				X
Health care (active duty service members and family)	X	X		
Living quarters allowance				X
Medicare-eligible retiree health care	X	X		
Miscellaneous expenses ^a	X	X		
Overseas cost-of-living adjustment		X		X
Overseas housing allowances—move-in housing, rental, utility, recurring maintenance		X		
Permanent change of station/relocation	X	X		
Postretirement health benefit, life insurance			X	X
Recruitment and advertising	X	X		
Retired pay accrual	X	X		
Severance/separation benefits			X	X
Special pay ^b			X	X
Training	X	X	X	X
Treasury contribution for concurrent receipts and to Medicare-eligible retiree health care fund	X	X		
Veterans benefits (cash and in-kind)	X	X		

SOURCES: CAPE, 2018a; CAPE, 2018b.

^a Miscellaneous expenses include CONUS cost-of-living allowance (if applicable), clothing allowance, and unemployment benefits.

^b FCoM defines special pay as consisting of overtime, holiday pay, incentive pay, and other performance awards. For civilians, FCoM estimates special pay as a fixed percentage of basic pay (e.g., 4.9 percent in FY 2018), regardless of occupation. In contrast, for active duty service members, FCoM requires information on occupation to estimate special pay. Because the prototype tool does not currently take occupation into consideration, we are unable to estimate special pay for active duty service members.

The FCoM cost factors are well documented in several other sources, including white papers written by CAPE that describe the cost factors in detail (CAPE, 2018a; CAPE, 2018b). Additionally, Knapp et al., 2020, describes the combinations of variables that are required to calculate the specific amount for each cost factor (i.e., service, pay grade, expected years of service or GS step of personnel filling the billets, and location). For example, for active duty billets, expected years of service of personnel filling the billets and pay grade are required to compute basic pay, whereas for GS civilian billets located in CONUS, GS grade and expected pay step and location are required to calculate basic pay. The intricacies of how FCoM cost factors are defined and estimated might be of particular interest to a small subset of readers. We encourage those readers to review the 2018 CAPE reports (CAPE, 2018a; CAPE, 2018b) and Knapp et al., 2020, for more information.

Prototype Tool Limitations

We note a few limitations in how the prototype tool calculates the cost of billets. First, the prototype tool does not estimate costs for reserve billets, civilian billets other than GS and Senior Executive Service (SES), or contractor billets because FCoM does not include cost factors for these groups.² Moreover, when estimating the cost for contractor billets, FCoM requires the user to provide the key inputs for the cost of each contractor billet (i.e., hourly rate, number of work hours, and nonlabor costs). To understand the effect of these exclusions on the share of the total DoD force for which cost can be estimated, we leverage data from the *Population Representation of the Military Services* report (Office of the Under Secretary of Defense, Personnel and Readiness, 2020) and from the online tool FedScope (FedScope, undated).³ We estimate that excluded groups make up approximately 35 percent of the total DoD force (excluding contractors, for whom there is no comprehensive count) as of the end of FY 2018.

Second, because occupation was not included in the computer code that was developed in Knapp et al., 2020, and leveraged for this effort, the prototype tool does not account for occupation. That means the prototype tool does not include FCoM occupation-specific cost factors, such as active duty special pays or civilian special salary rates. For some occupations

² Because the Defense Civilian Intelligence Personnel System pay schedule (GG) is currently the same as the GS pay schedule, the prototype tool costs out GG billets as GS billets.

³ Using these sources, we note that as of the end of FY 2018, the total active duty and reserve duty end strengths across the Air Force, Army, Marine Corps, and Navy were 1,304,418 and 796,716, respectively. In addition, total civilian employment across the four services was 641,995, with 156,936 on pay plans other than GS and SES. Altogether, the total combined active and reserve duty end strength and total civilian employment across the four services is 2,7432,098. Summing up the excluded groups, setting aside contractors, for whom no comprehensive count exists, (i.e., total reserve duty end strength plus civilian employment in pay plans other than GS and SES across all four services), we arrive at 955,234. Calculating the ratio of these two totals, we arrive at the excluded groups making up approximately 35 percent of the total DoD force (excluding contractors).

these excluded pays might be substantial and, therefore, depending on the occupation mix of the organization, the prototype tool’s estimates could understate the true cost by a nontrivial margin.

Third, FCoM does not contain a cost factor that accounts for the cost of personnel management for these workforces. Lastly, the prototype tool uses cost factors that are based on 2018 data, used in Knapp et al., 2020. Each of these limitations can be overcome in a follow-on effort, as discussed later in this report.

Prototype Tool Demonstration

Next, we demonstrate the utility of the prototype tool by estimating the cost of a hypothetical organization. We constructed a hypothetical organization akin to a combatant command in that it includes a mix of active duty and civilian billets from the four services across a wide variety of pay grades and locations.⁴ By demonstrating the prototype tool on this hypothetical organization, we showcase three key features: streamlining cost estimation for large DoD organizations, summarizing cost estimates in both tables and figures, and manipulating billet counts—and therefore total cost—directly in the prototype tool.

Streamlining Cost Estimations for Large DoD Organizations

FCoM allows the user to estimate cost for multiple billets, but the process is time-consuming—billets must be entered one by one. Instead, the prototype tool allows the user to upload a billet file and have cost factors applied to it, thereby streamlining cost estimation for large DoD organizations. The uploaded billet file must contain the UIC, which we use to identify location and service, and pay grade for each billet. Recall that computing the FCoM cost factors also requires information on the expected years of service of the personnel filling the billets. We compute expected years of service (for active duty billets) and step (for civilian billets) according to the distribution of years of service because step is often not associated with a specific billet.⁵ For more details on what is required in the billet file, see Appendix B.

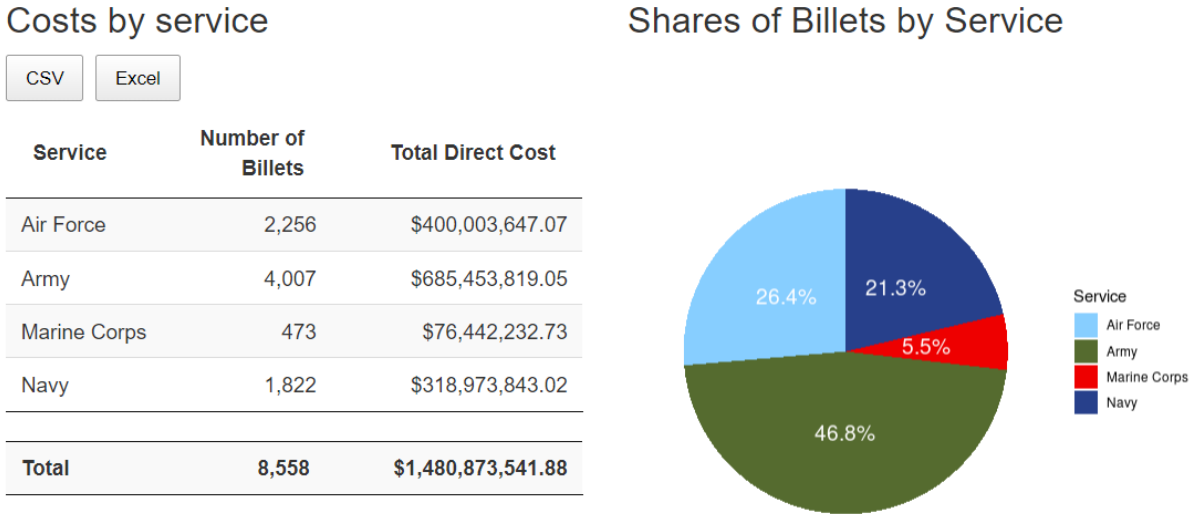
⁴ As described in Appendix A, if service is not included in the billet input file, the prototype tool can derive it from the unit identification code (UIC). The billet input file that the prototype uses is from a hypothetical organization, and the hypothetical billet input we constructed does not include service. Therefore, the prototype tool derives service from the UIC for all billets in the hypothetical organization. As a result, civilian billets in the hypothetical organization are associated with a particular military service. In reality, civilian billets might not be associated with a particular military service; in particular, they might be associated with a DoD fourth-estate agency. This complication can be explored further in a follow-on effort, when the prototype tool is used for actual billet files.

⁵ We follow the methodology used in Knapp et al., 2020, drawing on Defense Manpower Data Center (DMDC) Active Duty and Civilian Master Files. To compute expected years of service for active duty billets, we take the average of the 10th, 30th, 50th, 70th, and 90th percentile years of service associated with each pay grade–service combination from FY 2013 to FY 2018. To compute steps for civilian billets, we take the average of the 10th, 30th, 50th, 70th, and 90th percentile steps in the associated grade for Army civilians from FY 2013 to FY 2018. Only Army civilians are used in this computation. Knapp et al., 2020, explains that Army civilian records are “the most consistently connected in the DMDC data with the UICs of the service members they are jointly serving with.”

Summarizing Cost Estimates

Once the user uploads a billet file, the prototype tool provides an estimate of the cost associated with the full organization and summary tables and figures according to service, billet type (i.e., enlisted, officer, civilian), and pay grade. Figures 2.1 through 2.3 show this for the hypothetical organization we created. We generated the hypothetical organization to be representative of a combatant command headquarters, with a mix of cross-service active duty and civilian personnel. As Figure 2.1 shows, the hypothetical organization contains 8,558 billets that cost approximately \$1.48 billion per year.⁶ The figure also shows the billet count and cost by service, with the service mix being 46.8 percent Army, 26.4 percent Air Force, 21.3 percent Navy and 5.5 percent Marine Corps.

Figure 2.1. Summary of Annual Cost Estimates



NOTE: Authors’ estimates using the prototype tool and billet file for a hypothetical organization.

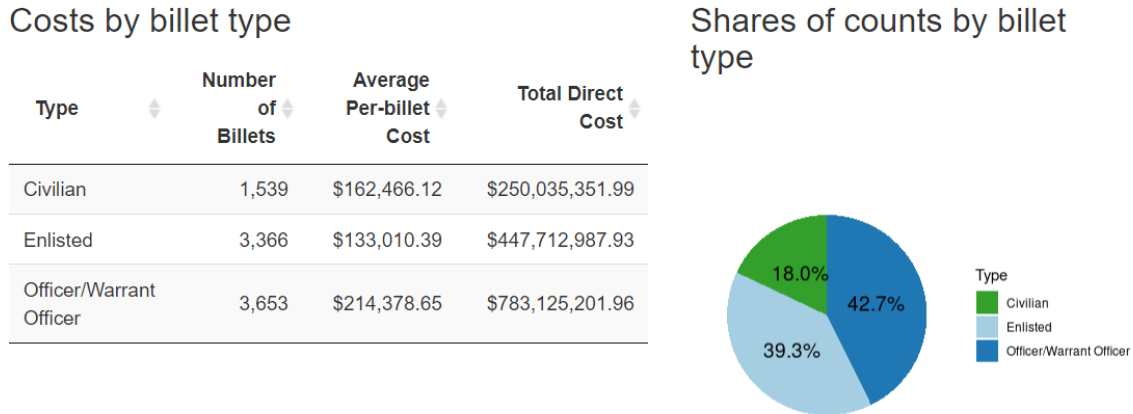
As Figure 2.2 shows, most of the billets are held by active duty officers (42.7 percent) and active duty enlisted service members (39.3 percent), with 18.0 percent held by civilians. And, as

Civilians in other services appear to frequently be assigned to different UICs.” We acknowledge that these computations would ideally account for differences by occupation, especially for expected years of service for active duty billets because that can vary considerably by occupation. However, we do not factor in occupation in these computations because the prototype tool currently does not take occupation into consideration.

⁶ Recall that the prototype tool does not estimate cost for reserve billets, civilian billets other than GS and SES, or contractors. As discussed in Appendix A, billet files that contain reserve billets, civilian billets other than GS or SES, and contractors will have those billets removed before the cost factors are applied to the file. The user can view and download the billets that are to be removed, and the user can also download the billet file after the cost factors have been applied with the removed billets added back in. However, because the removed billets do not have cost factors applied to them, the summary of cost estimates (total cost, billet count, service mix, etc.) as seen in Figure 2.1 would not reflect the removed billets.

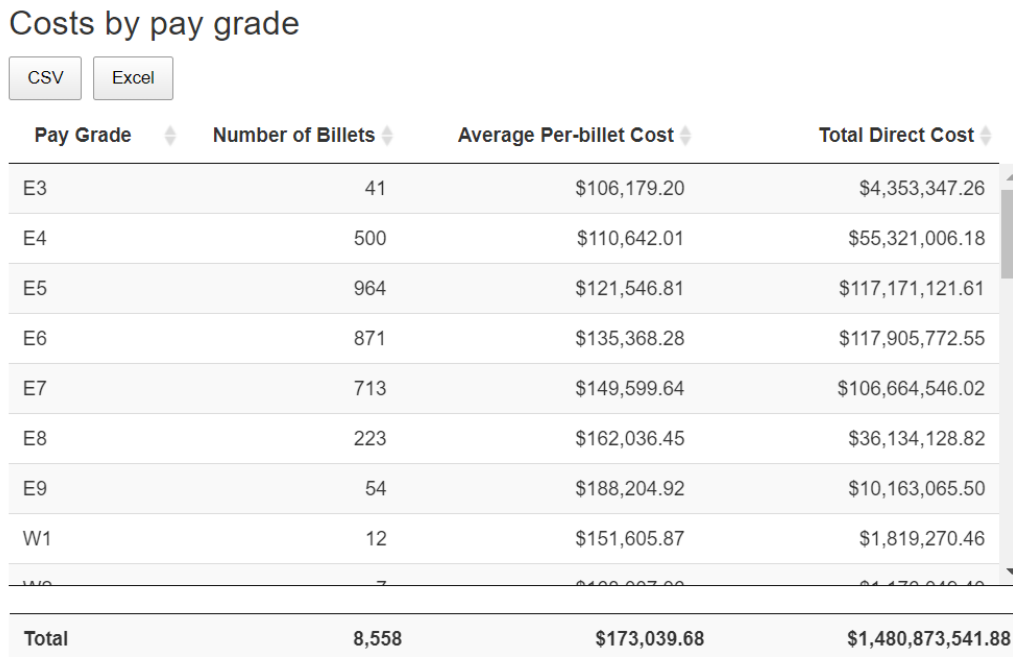
Figures 2.3 and 2.4 show, the prototype tool also displays billet counts and estimated costs by pay grade, separately for civilian, enlisted, and officer.

Figure 2.2. Summary of Annual Cost Estimates: By Billet Type



NOTE: Authors' estimates using the prototype tool and billet file for a hypothetical organization.

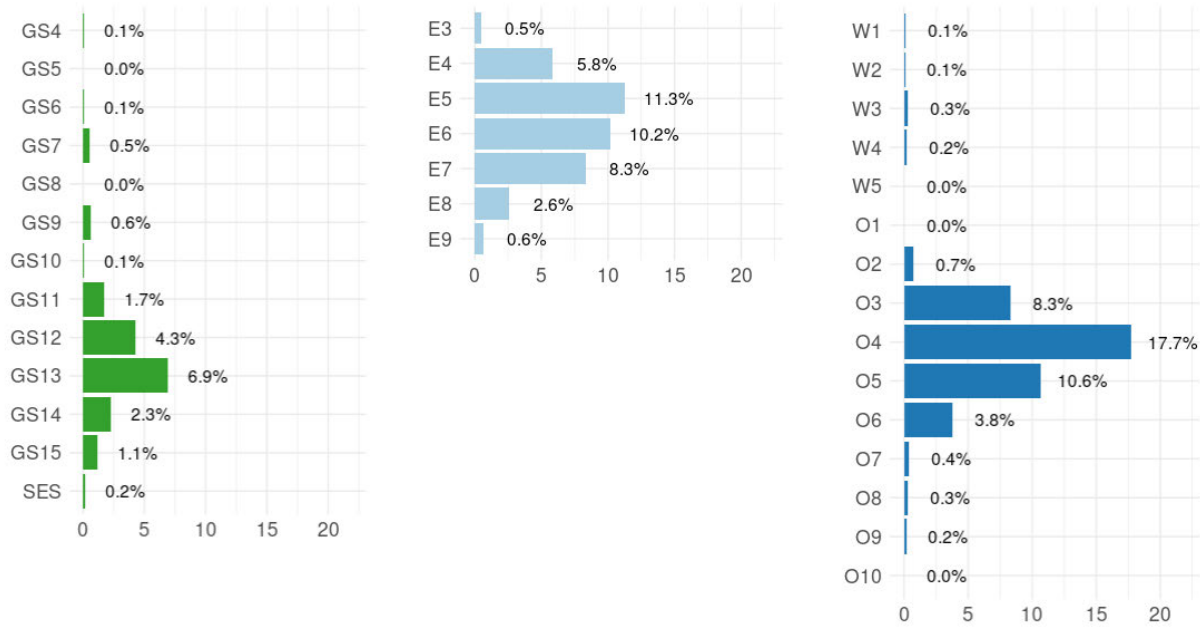
Figure 2.3. Summary of Annual Cost Estimates: By Pay Grade



SOURCE: Authors' estimates using the prototype tool and billet file for a hypothetical organization.
 NOTES: The table shown in this figure is a snapshot of what the user can view in the prototype tool. Here, the table appears truncated. However, in the prototype tool itself, the user can use the scroll bar on the right to view additional rows in the table.

Figure 2.4. Summary of Billet Counts: By Pay Grade

Shares of counts by pay grade

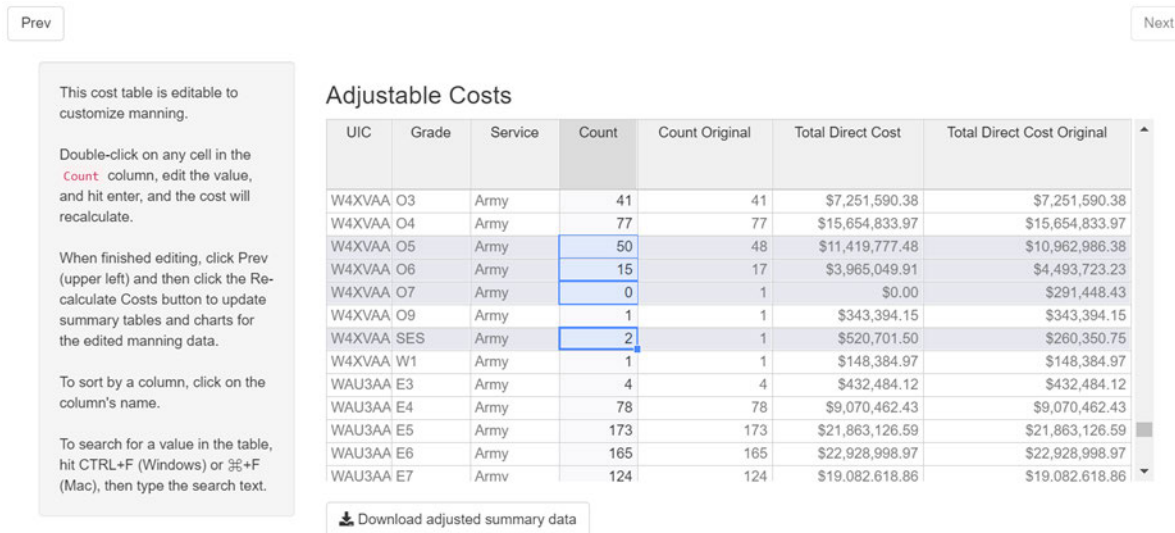


NOTE: Authors' estimates using the prototype tool and billet file for a hypothetical organization.

Manipulating Billet Counts and Cost

Finally, a user can run various scenarios by adjusting the billet count in the prototype tool itself and observing the effects on total cost. Consider a simple scenario: The Army wants to reallocate some senior officer billets away from the hypothetical organization, and at the same time the hypothetical organization is facing manpower budget cuts. Specifically, the hypothetical organization wants to estimate the effect on cost of changing an O-7 Army billet to a civilian SES billet and downgrading two O-6 Army billets to O-5 billets. Figure 2.5 shows how the user can manipulate the billet counts directly and the cost are recalculated instantaneously.

Figure 2.5. Manipulating Billet Counts and Observing the Effect on Annual Cost



NOTE: Authors' estimates using the prototype tool and billet file for a hypothetical organization.

As Figure 2.5 shows, the prototype tool displays the original billet count from the uploaded billet file in the column labeled “Count Original” and the associated total cost in the column labeled “Total Direct Cost Original.” The user can make the desired billet count changes in the “Count” column and observe the new total cost in the “Total Direct Cost” column. In this scenario, the changes to billet counts and associated total cost per year include

- decreasing the number of O-7 Army billets from one to zero, which decreases the total cost by approximately \$291,000
- increasing the number of SES Army billets from one to two, which increases the total cost by approximately \$260,000
- decreasing the number of O-6 Army billets from 17 to 15, which decreases the total cost by approximately \$529,000
- increasing the number of O-5 Army billets from 48 to 50, which increases the total cost by approximately \$457,000.

Altogether, changing three Army billets—replacing the O-7 billet with an SES billet and downgrading two O-6 billets to O-5 billets—reduces the total cost by approximately \$103,000 per year. The prototype tool will also allow the user to go back and observe the effect of the scenario on the mix across the services, billet types, and pay grades by reproducing the figures displayed in Figure 2.1 after having taken into account the billet changes made by the user.

We caveat this hypothetical scenario by noting that a change in military billets will not directly reduce military manpower outlays for most DoD organizations. At the organization level, this is because military manpower budgets are set and paid for at a higher headquarters. At the military-service level, this is because military billet changes do not directly affect overall end

strength. Indeed, unless a service is cutting end strength, military billets taken from one organization will simply be reallocated elsewhere in the service. Moreover, there are statutory constraints on the number and grade of officers in a service, which limit the extent to which officer billets can be downgraded. If the prototype tool is used to estimate effects on military manpower outlays, as would be the case if it is incorporated into a larger work-mix optimization model, these caveats must be addressed.

Additionally, cost factors should be adjustable if the prototype tool is developed further. The appropriate cost factors to include in an analysis depend on how it will be used. For example, we might need to consider whether the cost factors are appropriate for estimating the cost of both small and large changes in the numbers of billets. Some FCoM cost factors are marginal costs (e.g., basic pay), meaning they increase incrementally per billet. For marginal costs, it is reasonable to assume that the cost will increase or decrease consistently for small or large changes in the billet counts alike. Other costs will change unevenly because the nature of the activity is not immediately affected by the addition or reduction of a few positions (e.g., recruiting). For many of these costs, FCoM simply calculates the cost factor as the ratio of the full cost divided by end strength. However, it is unreasonable to expect that the actual cost would change in a meaningful way with only small changes in billets. Moreover, when calculating cost factors for costs that change unevenly, in some cases FCoM takes into consideration costs for active duty billets and other times FCoM takes into consideration costs for active duty and civilian billets. Whether FCoM's approach to calculating cost factors is appropriate depends on the question that the cost factors are being used to answer. These issues will need to be considered as we continue to develop the prototype tool.

In the final chapter of this report, we discuss next steps, both in terms of continuing to develop the prototype tool's capabilities and areas for future research in manpower cost modeling.

3. Next Steps

The prototype tool developed for this study shows how the process of developing cost estimates for large DoD organizations using FCoM cost factors can be streamlined. Although still only a prototype, this tool, with additional development, would be useful to fellow members of the DoD research community and DoD and service personnel involved in manpower policy and decisionmaking. With this tool, users will be able to easily and efficiently run various scenarios to estimate the cost associated with (1) a change in manpower mix (such as downgrading senior officer billets, as demonstrated in the previous chapter), (2) a change in requirements that comes about because of a change in mission, or (3) standing up a new unit.

There are many options to expand the prototype tool's capability. We list these in order of perceived complexity, from simplest to most complicated. First, the computer code and underlying data that calculate the cost factors could be updated from 2018 inputs to current-FY inputs. These updates should occur every FY, when new pay schedules take effect. Much of this work requires downloading publicly available and easily accessible information (e.g., pay tables). However, updating some of the underlying cost information requires coordination with the CAPE FCoM team.

Second, the prototype tool could incorporate occupation, so that it could consider specific cost factors, such as special pays or civilian special salary rates. Third, we could develop a method for computing cost factors for billets that are currently excluded from the prototype tool (i.e., reservists, civilians other than GS and SES, and contractors). Fourth, we could develop a methodology to account for the cost of personnel management of these workforces. Finally, we could revisit how FCoM cost factors are estimated, taking into consideration the costs that increase incrementally per billet and those costs that change more unevenly, and how to address this for both small and large changes in the numbers of billets.

Moreover, in developing the prototype tool, we tested it on billet data from a hypothetical organization. In addition to the potential enhancements listed above, there would be great benefit in applying the prototype tool to actual billet files from many different organizations. In doing this, we could uncover additional ways to improve the tool to make it more widely applicable. Because the tool is still a prototype and has only been tested on a hypothetical billet file, we are not making it available for distribution at this time. However, with additional development, our intent is to make the tool available for use by an outside audience. For instance, it could be added to the OSD analytic computing environment with access restricted to users with a CAC or PKI, just like FCoM. We note that the prototype tool was written in the R programming language. The benefits of using R are that it is free to all users, it is available in the OSD analytic computing environment, and it allows the programmer to easily build and host a web-based interface using

R Shiny. However, future versions of the tool could be developed using other programming packages, as desired.

More broadly, this prototype tool is a piece of a larger research agenda in the area of manpower cost modeling. Although the prototype tool can estimate the cost of large DoD organizations and enable various manpower cost scenarios, it cannot perform a work-mix optimization. A work-mix optimization model, which would have great practical uses for OSD and the services, would include the following elements:

- a cost estimate model that applies FCoM cost factors to billets, launching from the prototype tool developed here
- a workforce prioritization routine that allows the user to identify high-priority billets or billets that are military essential or inherently governmental
- a matching algorithm that pairs personnel with billets
- an optimization routine that starts with the current personnel and finds the optimal manning requirement constrained by a total manpower budget.

The inputs for such a work-mix optimization model would include the FCoM cost factors, billet priorities, and billet and administrative personnel data. The outputs would include the optimized manning requirement, the cost associated with that requirement, and potential trade-offs for the user to consider. As discussed, this broader model would need to take into consideration how the approach to estimating manpower costs would need to change when being applied to single DoD organization versus to a very large part of or an entire military service. Overall, such a model would produce consistent and repeatable cost estimates for the rationalization of the total force and enable quick and rigorous cost analyses as the department and the services face new and emerging manpower challenges and policy issues.

Appendix A. Prototype Instructions

In this appendix, we describe how to use the prototype tool. There are five steps:

1. The user uploads a billet file.
2. The prototype tool cleans the billet file to prepare for merging with the FCoM cost factors.
3. The cost factors are applied.
4. The prototype tool summarizes the cost output and allows the user to download the cleaned billet file with the cost factors applied.
5. The user can manipulate the billet counts within the prototype tool, to run various scenarios and observe the impact on cost.

To supplement Chapter 2, in this appendix we discuss each of these steps and demonstrate them being applied to a hypothetical organization. We generated this billet file to include a large mix of cross-service active duty and civilian personnel—a mix that might be found at a combatant command headquarters, for instance—to showcase the prototype tool’s capabilities.

Step 1: Upload a Billet File

The user begins by supplying a billet file, where each row lists a new billet and the associated pay grade and UIC, which the tool uses to apply the cost factors.⁷ When the user first opens the prototype tool, they see a list of the following formatting requirements for the billet file on the introduction page (Figure A.1):

- The format of the billet file must be an Excel file (.xlsx or .xls) or a text file with a comma (.csv), semicolon, or tab (.tsv) delimiter.
- The first row of the billet file must contain column names.
- The billet file must include a UIC and a pay grade for each billet, and these columns must be labeled something similar to “uic” and “grade,” respectively.⁸ The billet file might

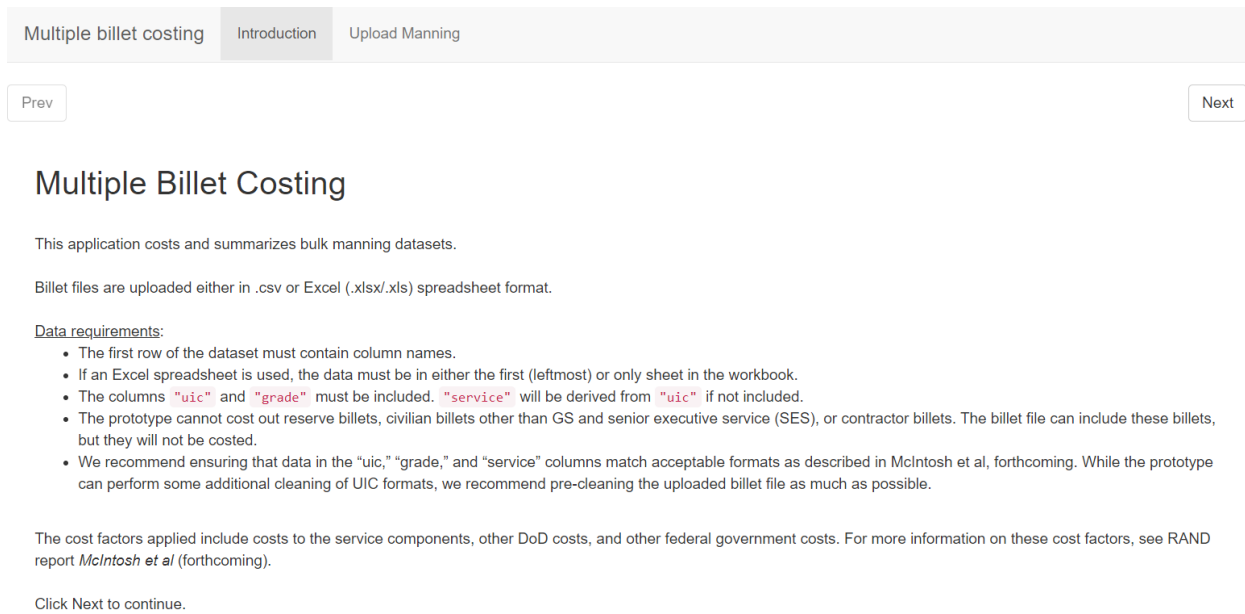
⁷ FCoM requires a location to estimate the cost of a billet because there are locality pays that account for cost-of-living differentials. However, because billet files do not consistently include location, the prototype tool applies location using a UIC-location crosswalk. The crosswalk was created for the Knapp et al., 2020, study, using DMDC active duty and civilian master files, which contain information on both UIC and location. The UIC-location crosswalk matches each UIC to a single location. Because there can be multiple locations that correspond to a UIC in the DMDC data, the UIC-location crosswalk matches each UIC to the location that has the largest number of service members or civilians associated with it in the DMDC data.

⁸ Specifically, there must be a column including “uic” somewhere in its label and another column including either “grade” or “grd” somewhere in its label.

include service, and if it is included, it must have “service” in the column title. However, this is not required because the prototype tool can derive the service using UIC.⁹

The user is also made aware that contractors, reservists, and civilians not on GS or SES pay plans will not be included in the cost estimate provided by the prototype tool.

Figure A.1. Prototype Tool Introduction Page



Next, as Figure A.2 shows, the user uploads a billet file by selecting the file type and specifying its location. Once the billet file is uploaded, the user can view the billet file to ensure that the file was uploaded correctly (Figure A.3). The billet file used in this appendix is from the same hypothetical organization we discussed in the main body of this report.

⁹ The prototype tool uses the first character of the UIC to determine service: “F” for Air Force, “W” for Army, “M” for Marine Corps, and “N” for Navy.

Figure A.2. Uploading a Billet File

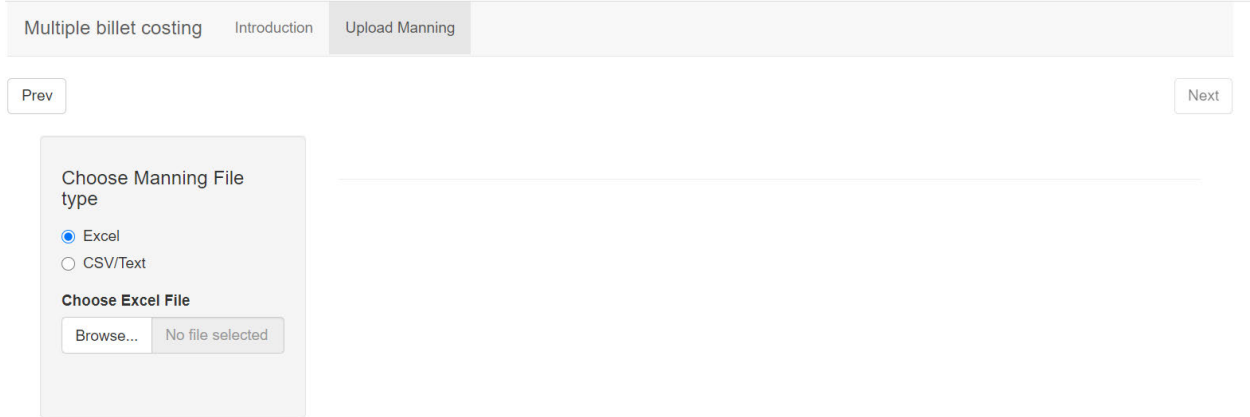
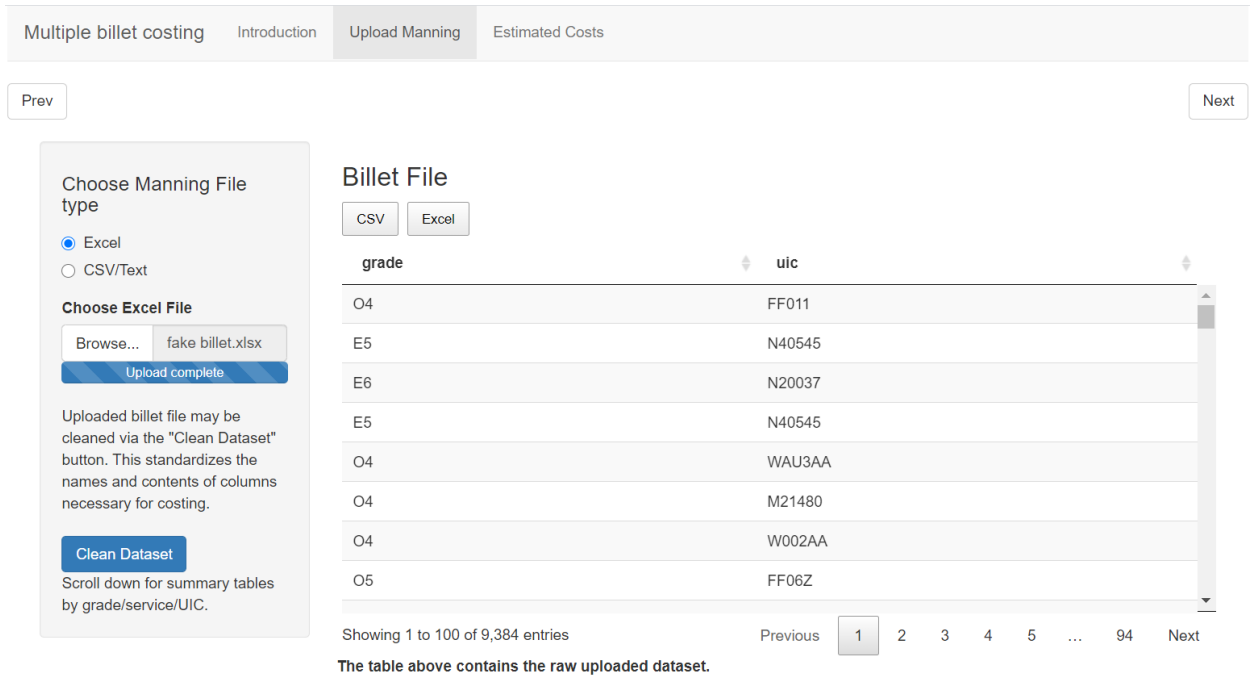


Figure A.3. Reviewing the Uploaded Billet File



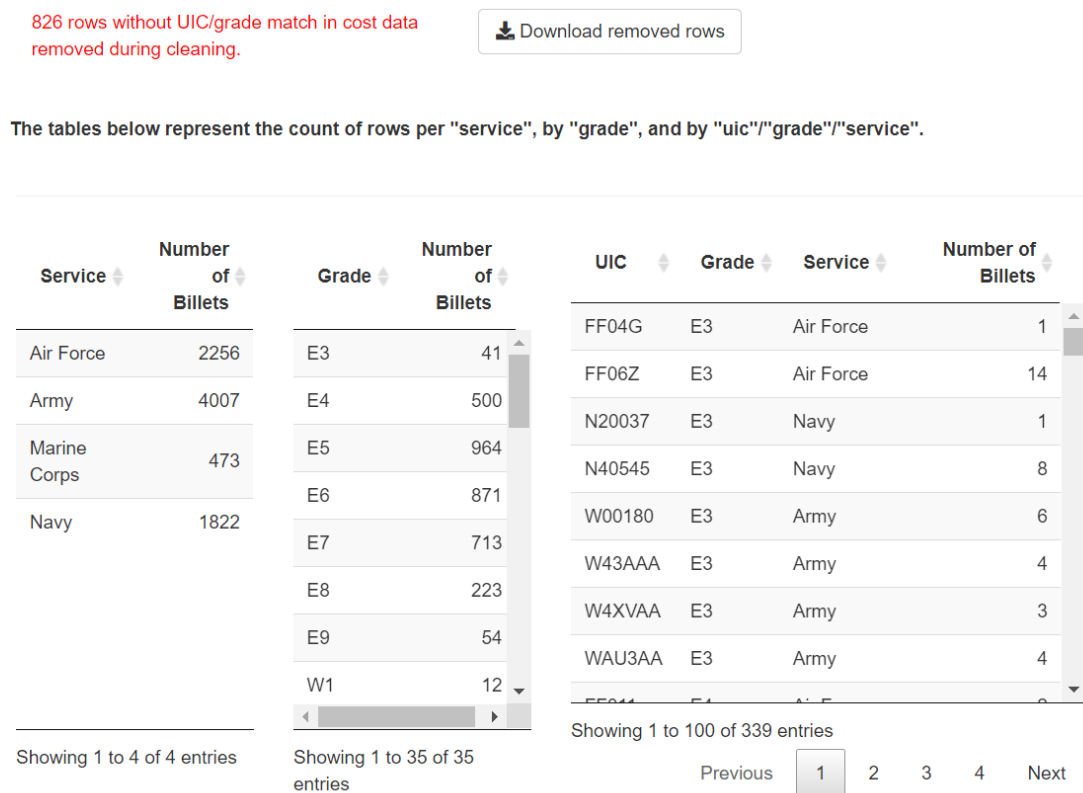
Step 2: Prepare the Billet File for Merging with Cost Factors

After the user uploads the billet file, the prototype tool cleans the billet data, preparing to apply the cost factors, by clicking the “Clean Dataset” button (Figure A.3). The cleaning entails locating columns for UIC, pay grade, and service (if included); standardizing the formatting of UIC and pay grade values; and deriving service from UIC (as necessary).

After this cleaning process, there might be billets that cannot be matched to cost factors because they are associated with a UIC and pay grade combination for which there is no FCoM

cost factor. These billets are likely reservist, contractor, or civilian, not on the GS or SES pay plans. These billets that are not matched will be removed from the file before the tool proceeds with applying cost factors, and the user can download and view these billets using the “Download removed rows” button (Figure A.4). By downloading these rows, the user can inspect them to determine whether there are errors in UIC or pay grade that are preventing these billets from being included. If there are errors to fix, the user must edit the initial billet file and reupload it. The tool also displays the number of billets that will have cost factors applied, summarized by service, pay grade, and UIC (Figure A.4). Appendix B provides more detail about appropriate formats for the billet file and the cleaning process the prototype tool uses if the billet file is not in the correct format.

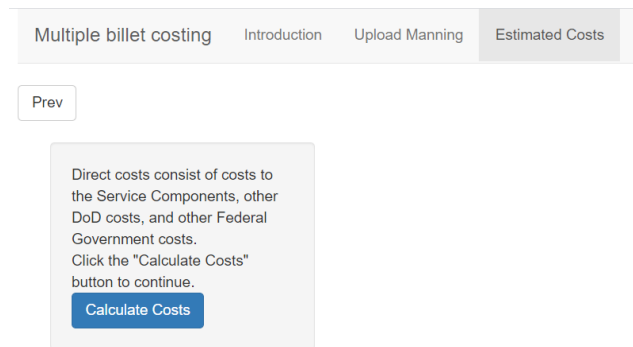
Figure A.4. Cleaned Billet File



Step 3: Apply the Cost Factors

With the billet file cleaned, the prototype tool displays the cost factors that will be applied (Figure A.5). These are the same cost factors listed in Chapter 2. When the user clicks “Calculate Costs,” the prototype tool applies the FCoM cost factors to the billet file.

Figure A.5. Cost Factors to Be Applied



Step 4: Summarize the Cost Output and Download the Merged Billet File

After applying cost factors to the billets, the prototype tool displays summary tables and figures, as described in Chapter 2. These include the number of billets and total cost associated with those billets, by service (Figure 2.1), billet type, (i.e., civilian, enlisted, officer and warrant officer [Figure 2.2]), and pay grade (Figures 2.3 and 2.4). Additionally, the user can download the data behind the summary tables and figures (i.e., the billet data with the cost factors applied).

Step 5: Manipulate Billet Counts for Various Scenarios

A key feature of the prototype tool is the ability to run various manpower policy and budgeting scenarios, in which the user can observe how changes in billets affect cost. One way a user can do this is by editing the original billet file, running it through the prototype tool, and comparing the output from the original and edited billet files. Another option is for the user to change the number of billets associated with a specific UIC, pay grade, or service within the prototype tool itself, as described in Chapter 2 (Figure 2.5).

After the cost of the original billet file has been calculated, the prototype tool displays a table that summarizes the billet count by UIC, pay grade, and service and shows the total cost associated with those billets. The column labeled "Count Original" is the number of billets that were in the original billet file. The user can manipulate the number of billets by changing the value in the "Count" column and the total cost will automatically update. Additionally, after making changes to billet counts, the user can click on the "Prev" button to return to the previous screen, click the "Recalculate Costs" button, and view updated summary tables and figures reflecting the billet changes. As described earlier, the user also can download the adjusted billet data with the cost factors applied.

Appendix B. Description of Billet File Formats

This appendix describes appropriate formats for the billet file and the cleaning process the prototype tool uses if the billet file is not in a usable format. We recommend ensuring that the billet file is already in the final format at the time of upload to avoid unintended mistakes during the cleaning process. Recall that cost factors are determined by pay grade and UIC. As a result, the billet file must contain two columns, pay grade (“grade”) and UIC (“uic”). In the remainder of this appendix, we describe the final formats and cleaning procedures for each of the columns, grade and UIC. We also describe why a user might wish to include a “service” column in the billet file.

Pay Grade

Pay grade must be included in the billet file because it is used to calculate some of the cost factors, including basic pay and basic allowance for housing.

Final Format

There are 24 pay grades. There are nine enlisted pay grades, denoted as E0X, where “X” takes values between 1 and 9. There are ten officer pay grades, denoted as OXX, where “XX” takes values 01 and 10. There are five warrant officer pay grades, denoted as WX, where “X” takes values between 1 and 5. There are 15 GS pay grades for civilians, denoted as GSXX, where “XX” takes values between 01 and 15. SES is also an acceptable pay grade.

Cleaning

The prototype tool will also accept and clean other grade formats. Grades that consist of a text prefix and a numeric suffix (e.g., E0X, OXX, WX, or GSXX) might have their prefix and suffix separated by any combination of spaces, hyphens, em dashes, en dashes, and underscores. The prefix may begin with “M” or “C,” and text might be lowercase or uppercase. The numeric suffix might be entered with or without a leading 0 for values less than 10. For example, for grade W-3, the prototype tool will accept alternatives, such as “MW3,” “CW_3,” “w – 3,” and “W03,” and replace them with “W3.”

Additionally, the prototype tool identifies several acceptable grades: The prototype identifies any pay grade starting with “EE” or “ES” as an SES billet and any pay grade containing “GG” as a GS billet. Any other pay grade (typically billets on other civilian pay plans) will be marked as “Other” in the prototype tool.

UIC

Recall that UICs are a required column in the billet file because they are used to link billets to location. Location is not always included in billet files, and when location is included it might not be in consistent formats, making it difficult to match to cost factors. Instead, we use UIC to identify location according to DMDC locations.¹⁰

Final Format

Because we base our locations off of a UIC-location crosswalk built on DMDC data, the UIC format required by the prototype is the format used in the DMDC data. For the remainder of this section, we refer to these UICs as “DMDC UICs.” DMDC UICs typically begin with a “W” (Army), “N” (Navy), “F” (Air Force), or “M” (Marine Corps) and are followed by four or five alphanumeric characters. The UICs that we are able to match to cost factors (and are therefore acceptable formats) are UICs that were associated with at least one service member or civilian in the 2018 DMDC active duty and civilian master files.

Cleaning

Typically, UICs are not listed in billet files (“billet UICs”) in the final (DMDC UIC) format for the prototype tool, but they often can be converted to the final DMDC UIC in a consistent pattern that varies by service (Department of Defense Instruction 1336.05, 2009). If a UIC is not already in the final format at the time of upload, the prototype tool will attempt to convert the uploaded UIC to a DMDC UIC so it can be matched appropriately to cost factors. This procedure varies by service. As a result, if the user wishes to have the UICs converted in the billet file to DMDC UICs, they must also provide a service column according to the following:

- Army billet UICs are already typically in the DMDC format and require no changes.
- Navy billet UICs start with an “N.” For example, a billet UIC 00111 would become N00111 as a DMDC UIC.
- Marine Corps billet UICs are typically Monitored Command Codes (MCCs) if a joint billet file or Reporting Unit Codes (RUCs) if a Marine Corps billet file. We convert these MCCs and RUCs to DMDC UICs using a crosswalk available to CAC holders through the Marines Logistics Command website (Marine Corps Logistics Command, undated).
- Air Force DMDC UICs can be derived from the Air Force Personnel Accounting Symbol (PAS) code, which is a string of eight alphanumeric characters. To convert the PAS code to a DMDC UIC, we add an “F” to the last four characters of the PAS code. For example, PAS code ABCDEFGH would be FEF GH as a DMDC UIC.

¹⁰ As described in the main report, the prototype tool determines location using a UIC-location crosswalk. The crosswalk was created using DMDC active duty and civilian master files, which contain information on both UIC and location. The UIC-location crosswalk matches each UIC to a single location. Because there can be multiple locations that correspond to a UIC in the DMDC data, the UIC-location crosswalk matches each UIC to the location that has the largest number of service members or civilians associated with it in the DMDC data.

Service

The prototype tool does not require the billet file to contain a service column. However, if the billet file does not contain service, the prototype tool will be unable to convert billet UICs to DMDC UICs, as described above. If the billet file does not contain service but does contain DMDC UICs, the prototype tool will derive service according to the DMDC UIC.

Final Format

The final format for service is “Army,” “Navy,” “Marine Corps,” “Air Force,” and “Other DoD.”

Cleaning

If the billet file does not contain service but does contain a UIC column, containing DMDC UICs, the prototype tool derives service according to the first character of the DMDC UIC. If the UIC

- starts with an “A,” the service becomes “Army”
- starts with “N,” the service becomes “Navy”
- starts with “M,” the service becomes “Marine Corps”
- starts with “F,” the service becomes “Air Force”
- starts with any other character, the service becomes “Other DoD.”

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