Transportation Management Center Staffing and Scheduling for Day-to-Day Operations

Tool Test Protocol

October 2005

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Performed for the Transportation Management Pooled Fund Study, Raj Ghaman, Contract Officer's Task Order Manager.

16. Abstract

The Tool Test Protocol provides the testing methods and evaluation procedures for the TMC Staffing and Scheduling Tool.

The Transportation Management Center Staffing and Scheduling for Day-to-Day Operations Tool Test Protocol addresses plans for user representatives to perform evaluations of the TMC Staffing and Scheduling Tool. This Tool Test Protocol will be used to evaluate the accuracy, usability, and usefulness of the software tool.

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1 Introduction

1.1 Identification

The research presented in this document was performed by the Georgia Tech Research Institute (GTRI) under the sponsorship of the Federal Highway Administration (Contract No. DTFH61-01-C-00049). The contract officer's task order manager (COTM) is Raj Ghaman. The GTRI project director for this contract is Dr. Dennis J. Folds. The work was performed by researchers in GTRI's Electronic Systems Laboratory (ELSYS).

1.2 Purpose

The effective and efficient operation of transportation management centers (TMCs) depends on numerous factors including the utilization of human resources. The development of staff planning and scheduling systems to support the day-to-day operations of TMCs has been somewhat limited to this point. The primary objective of the contract is to provide a Technical Document for managers, supervisors, human resources personnel, and private contractors who are responsible for TMC staffing and scheduling. The Technical Document will addresses the concepts, methods, processes, tasks, techniques, and other issues related to work analysis – including staff scheduling and staff planning. The second objective is to create an easy-to-use tool that will assist TMC managers in making staff planning and scheduling decisions. The third objective is to define the functional requirements for an interactive software tool, to be developed in a subsequent initiative, that will fully support TMC managers in making staffing and scheduling decisions.

The present document includes a draft of the test protocol to be utilized in the evaluation of the TMC Staffing and Scheduling Tool, including identification of the specific tests to be performed, resources required to conduct the tests, and a schedule of the tests.

The following requirements in the Statement of Work are applicable to the Tool Test Protocol:

> "*The Contractor shall submit a protocol for testing the simplified Staffing and Scheduling Tool in a TMC. The test shall evaluate the accuracy, usability, and usefulness of the tool. The Contractor shall work with the COTM to identify a TMC manager who will use and test the tool in accordance with the evaluation protocol.*"

1.3 Definitions

The primary standard for the design of the user interface and interaction of the TMC Staffing and Scheduling Tool is ISO 9241, entitled *Ergonomic requirements for office work with visual display terminals*. ISO 9241 part 11 provides guidance on usability, and this test protocol adopts the following definitions with respect to usability of the tool's user interface:

Usability	*The extent to which a product can be used by specified users to achieve specified goals with **effectiveness**, **efficiency** and **satisfaction** in a specified context of use.*
Effectiveness	*The accuracy and completeness with which specified users can achieve specified goals in a particular environment.*
Efficiency	*The resources expended in relation to the accuracy and completeness of goals achieved.*
Satisfaction	*The comfort and acceptability of the work of the system to its users and other people affected by its use.*

2 Test Protocol

The protocol described in this document details the methods of usability testing planned for the evaluation of the TMC Staffing and Scheduling Tool. The primary purpose of this test plan is to assess users' ability to use each of the tool's functions, and users' ability to produce and understand the tool's outputs. This test protocol uses a combination of two formative approaches to usability testing: (1) an expert inspection and heuristic evaluation of the software functionality and user interface to be conducted by one or more human factors engineers who possess the skills required to perform these usability analyses, and (2) user-in-the-loop testing to be conducted after initial software development of the tool is complete. The usability test approaches are tailored to the specifics of the software design, with regard to the scope and functionality of the tool.

2.1 Description

The TMC Staffing and Scheduling Tool is a simple software tool designed to assist TMC managers in making scheduling decisions. The tool allows users to define any number of shifts with any number of work hours in a 24 hour period, and allows users to input the demand (in terms of the number of operators required) for each hour of the day for each day of the week. Once the demand information is entered by the user, the tool calculates the number of employees needed for each shift on each day of the week, and the day on which each employee starts his or her work week (assuming a 5 on/2 off work week). The tool also calculates two other values, "scheduling efficiency" and "excess hours per week," that are measures of the efficiency of the calculated schedule. With a few additional inputs, the tool can also calculate the "relief factor" for the TMC, which accounts for the average number of days off employees receive and increases the required number of employees accordingly.

2.2 Test Objectives

Two test objectives were identified to fully evaluate the usability of the user interface of the TMC Staffing and Scheduling Tool.

> **Objective 1:** To identify potential usability problems with the tool's functionality and output content as early as possible, ideally with sufficient time to conduct iterative modifications of the tool (if required) prior to end-user testing. The areas to be evaluated include the *effectiveness* and *efficiency* of the input and output components of the tool's user interface. The objective will be accomplished via expert inspection and heuristic evaluation of the tool using the usability principles described in Appendix A. The expert evaluation will be performed by a human factors engineer who is trained to conduct usability analyses.
>
> **Objective 2:** To receive end-user feedback from domain experts regarding the usability and usefulness of the TMC Staffing and Scheduling Tool. This will involve user testing by at least one designated TMC manager following pre-defined scenarios to complete the evaluation. Areas to be evaluated include the ease of use of the input components of the software tool, ease of understanding and interpretation of the output components of the tool, the degree of *satisfaction*

with the adequacy of the tool, and its value to practitioners. This will be accomplished through user completion of evaluation scenarios, documentation of difficulties, suggestions for design changes, and subjective ratings of items as specified in Appendices B through D.

2.3 Methods

Two separate evaluations will conducted, one to achieve each of the identified objectives.

Evaluation I is an expert human factors engineering analysis of the software tool's user interface with regard to its compliance with the general usability principles provided in Appendix A. Evaluation I uses a usability inspection method known as heuristic evaluation. Heuristic evaluation is a systematic inspection of a user interface as performed by a small set of expert human factors engineer who examine the interface and judge its compliance with recognized usability principles (i.e., the "heuristics"). The heuristic evaluation is one of the most widely used usability inspection methods in the industry. An expert heuristic evaluation is ideal for the current application due to its relative ease of implementation and economy of resources. The goal of the heuristic evaluation is to identify usability issues in the design so that any problems can be attended to as part of an iterative design process.

The design principles used for Evaluation I (see Appendix A) were developed by two renowned experts in usability engineering techniques, Jakob Nielsen and Ben Shneiderman. Current user interface standards and usability guidelines typically have on the order of one thousand rules. *Jakob Nielsen's Ten Basic Usability Principles*[1] and *Ben Shneiderman's Eight Golden Rules of Interface Design*[2] are shorthand references that distill the full set of rules down to a few key principles called *heuristics.* Each heuristic is related to one or more detailed interface design rules defined within the various standards and guidelines. Because of this relationship between the heuristics and the user interface design rules, the evaluator must be familiar with the specific intent of the heuristic as well as its corresponding interface design standards Therefore, Evaluation I will accomplish the first test objective by utilizing professional human factors knowledge and usability engineering experience to assess the effectiveness and efficiency of the software tool's user interface and functionality.

Evaluation II is an inspection by a domain expert (e.g., a TMC manager or other participants who are directly involved in TMC staffing and scheduling). The purpose of the inspection from the domain expert is to get feedback from the expected user population on the accuracy, usability, and usefulness of the software tool. The goal of Evaluation II is to achieve the second test objective by utilizing end-user knowledge and experience to assess ease of use of the software tool, the degree of satisfaction with the tool, and the value of the tool to practitioners.

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[1] Nielsen, Jakob. (1993). Usability engineering. San Diego, CA: Academic Press.

[2] Shneiderman, Ben. (1992). Designing the user interface: Strategies for effective human-computer interaction. Reading, MA: Addison-Wesley.

2.3.1 Resources Required

Resources include test equipment, expert evaluators, and TMC personnel.

Test Equipment

Test equipment includes the TMC Staffing and Scheduling Tool software files and a computer that meets the following specifications:

- Operating System: Microsoft Windows 2000 or XP.
- Support Software: This program requires the Java Runtime Environment (JRE). Computers without the JRE or a Java SDK installed may obtain the **JRE 5.0 Update** from http://java.sun.com/j2se/1.5.0/download.jsp.

  Note 1: The TMC Staffing and Scheduling Tool **does not** require any installation other than simply copying the files onto the computer being used.

  Note 2: The TMC Staffing and Scheduling Tool must be run from a drive with a letter (e.g., C:), rather than from an unmapped network share.

Evaluation I – Inspection by Human Factors Expert

At least one human factors engineer will perform the heuristic evaluation. In general, involving multiple evaluators improves the effectiveness of the heuristic evaluation method significantly.

The following resources are required to perform the heuristic evaluation (Test Objective 1):

- Software tool, with minimum requirements specified above
- Some familiarity with the software tool (e.g., understand the purpose of the tool, who will be using the tool, and how it is meant to be used)
- Detailed knowledge of accepted usability principles (Appendix A)
- Skills necessary to execute appropriate expert evaluative inspections

Evaluation II – Inspection by Domain Expert

For the domain expert evaluation, at least one individual directly involved in TMC management and planning will evaluate the software. It will be up to the TMC to decide whether more than one person will participate in the evaluation. Participating sites are TBD; the TMCs will be selected under the guidance of the COTM. GTRI expects that the user-in-the-loop testing will not require on-site presence by GTRI at the participating sites for the evaluation. GTRI researchers will be available to provide phone support for evaluators during normal working hours.

The following resources are required to perform the domain expert evaluation (Test Objective 2):

- Software tool, with minimum requirements specified above
- Stopwatch

- Evaluation packet, which specifies usability issues and provides space for user feedback
- Writing utensils
- Blank paper for additional comments

2.3.2 Procedure

Every attempt will be made to perform the heuristic evaluation prior to the user-in-the-loop testing so that recommended design changes resulting from the evaluation can be implemented into the software. At a minimum, any interface component that violates human factors/usability principles and receives a severity score of 4, which indicates a critical usability problem (see section 2.3.3, Measures), will be corrected prior to end-user evaluations.

Evaluation I – Inspection by Human Factors Expert
The heuristic evaluation is performed by having each evaluator inspect the interface independently. Only after all evaluations have been completed should the evaluators communicate to aggregate their findings (this procedure is important in order to ensure independent and unbiased evaluations from each evaluator).

During the evaluation session the evaluator interacts with the interface numerous times to inspect each interface component, and compares implementation of the interface components with a list of recognized usability principles (the heuristics) described in Appendix A. In addition to the checklist of general heuristics to be considered for all interface components, the evaluator may also consider any additional usability principles or results that may be relevant for any specific element. Of specific concern to the evaluator are the degree of achievable accuracy and completeness (i.e., system *effectiveness*) of the user interface input and output components, as well as the relative level of effort required to obtain the desired degree of effectiveness (i.e., system *efficiency*).

The output of the expert heuristic evaluation is a list of usability issues in the interface, with references to any usability principles that were violated. It is not sufficient for evaluators to simply say that they do not like a particular interface element; they should explain why they do not like it with reference to the heuristics or to other usability results. Being as specific as possible, evaluators should annotate each usability problem separately so that the problematic aspect of a component is easily identifiable during the redesign process. Additionally, positive aspects of the interface design should also be noted, so that they are not inadvertently removed in a subsequent redesign.

Evaluation II – Inspection by Domain Expert
Participants in the end-user evaluation will be asked to perform a series of tasks which are arranged into *Usability Evaluation Scenarios* as documented in Appendix B. Each participant will record their experiences on the *User*

Experience Log, which is documented in Appendix C, and the *Domain Expert Evaluation Form*, which is documented in Appendix D.

2.3.3 Measures

System performance measures will be taken in conjunction with the evaluations. The areas to be assessed in Evaluation I include the *effectiveness* and *efficiency* of the input and output components of the tool's user interface. The areas to be assessed in Evaluation II include the ease of use of the input components of the software tool, ease of understanding and interpretation of the output components of the tool, and degree of *satisfaction* with the adequacy of the tool and its value to practitioners.

Evaluation I – Inspection by Human Factors Expert

In the heuristic evaluation, each human factors expert assesses the system and notes violations of any interface design principles that would indicate a potential usability problem. The evaluator also assesses the severity of each usability problem, based on four factors: how common is the problem, how easy is it for the user to overcome, is it likely to be a one-off problem or one that persists, and how seriously will the problem be perceived? These four factors can be combined to provide rationale for overall severity rating scores that fall on a scale of 0 to 4:

0 – Not a usability problem	May be used to document positive aspects
1 – Cosmetic problem only	Need not be fixed unless extra time allows
2 – Minor usability issue	Fixing this should be given a low priority
3 – Major usability issue	Important to fix, and should be given higher priority
4 – Critical usability problem	Imperative to fix this before the product is released

Evaluation II – Inspection by Domain Expert

The performance measure for the end-user portion of the usability testing is a rating for each item under evaluation. Ratings will be made on a four point scale, with 1 being unsatisfactory and 4 being satisfactory. These judgments should be made on the following basis:

1 – Unsatisfactory	Difficult to use or inadequate content
2 – Marginally Unsatisfactory	Usable, but an alternative implementation or explanation would be considerably better
3 – Marginally Satisfactory	Minor suggestions for improvement
4 – Satisfactory	Happy with functionality and content

Evaluations will result in satisfactory/unsatisfactory judgments from the participants for each element of design under test. In addition, users will be asked to record additional information such as task duration, an assessment of tool usefulness, suggestions for design changes, and a log of difficulties experienced

during the performance of the task (either due to the design of the tool or software bugs).

2.4 Results – Data Reduction and Planned Analysis

The results data in Evaluation I will target discussion of the *effectiveness* and *efficiency* of the input and output components of the tool's user interface. In Evaluation II, results data will reflect the ease of use of the input components of the software tool, ease of understanding and interpretation of the output components of the tool, and degree of *satisfaction* with the adequacy of the tool and its value to practitioners.

Evaluation I – Inspection by Human Factors Expert

Once all evaluator assessments are aggregated, usability issues will be documented and the mean severity ratings for each issue will be calculated. Since the heuristic evaluation aims at explaining each observed usability problem with reference to established usability principles, it will often be fairly easy to recommend a revised design according to the guidelines provided by the principles for good interactive systems. These recommendations will be also documented in the evaluation results. A summary of the inspection findings will be prepared and presented as an Evaluation Test Report in Task C.3.

Evaluation II – Inspection by Domain Expert

Ratings for each usability issue will be tabulated and reported, and an overall usability score will be assigned for the tool. Ratings data will be summarized as appropriate for the scale used. For numerical scales (interval or ratio scales of measurement), the mean, standard deviation, and range of ratings will be calculated for each item. For all rating scales, frequency (mode) of individual ratings will be calculated. In addition, an analysis of user observations associated with each issue, along with any suggested design changes, will be reported. No inferential analyses will be performed for the rating data. Data analysis will consist of data reduction and evaluation of that reduced data by the human factors team. Any conclusions drawn by the analysis of subjective data will be verified by a second human factors engineer.

2.5 Criteria

During the inspection by the human factors expert, determination of compliance with the various usability principles and guidelines will be rendered by the human factors engineer performing the inspection. Each compliance determination will be justified with appropriate rationale with respect to the principle or guideline that was violated.

In the domain expert evaluation, the degree of usability will be judged according to the perceived usability and usefulness of each tool feature or component.

If any nonstandard issues are identified by the evaluators, GTRI will follow up with them to determine more specifics of their hardware configuration to determine if the issue is a result of not meeting the minimum system requirements, or if it is a serious error that

needs to be fixed for use on the specified system. Unsatisfactory ratings will be evaluated to determine what, if any, design changes will be made.

2.6 Technical Risks

There are no identifiable technical risks involved in performing the human factors expert evaluation. The only technical risk involved with performing the domain expert testing is the availability of participants within the timeframe needed to complete the testing on schedule.

List of Acronyms and Abbreviations

COTM	Contract Officer's Task Order Manager
GTRI	Georgia Tech Research Institute
ISO	International Standards Organization
TBD	To Be Determined
TMC	Traffic Management Center

Appendix A Usability Principles for Expert Inspection

This appendix describes the principles and guidelines that will be used by the human factors evaluators during the expert inspection.

Jakob Nielsen's Ten Basic Usability Principles
The following general usability guidelines ("heuristics") are broad principles for user interface design. Nielsen and others have long been advocates of rapid, low-cost evaluation, including expert inspection of interfaces. The design heuristics outlined below are widely used in industry.

1. **Visibility of system status** - The system should always keep users informed about what is going on, through appropriate feedback within a reasonable time frame.
2. **Match between system and the real world** - The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
3. **User control and freedom** - Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
4. **Consistency and standards** - Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. **Error prevention** - Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
6. **Recognition rather than recall** - Minimize the users' memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
7. **Flexibility and efficiency of use** - Accelerators - unseen by the novice user - may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8. **Aesthetic and minimalist design** - Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.
9. **Help users recognize, diagnose, and recover from errors** - Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
10. **Help and documentation** - Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Nielsen, Jakob. (1993). Usability engineering. San Diego, CA: Academic Press.

Ben Shneiderman's Eight Golden Rules of Interface Design

These rules are intended to be used during the design and development of the system but can also be applied, like Neilson's heuristics, to the evaluation of systems. These rules provide a useful shorthand for describing a much more detailed set of design principles, and should be interpreted by evaluators who possess a solid understanding of the detailed design principles, and who are thus able to articulate the relevance of the rule to the interface being evaluated (e.g., how and why the rule was either violated or appropriately applied).

1. **Strive for consistency.** There are many levels of consistency, including action sequences, terminology, menus, fonts, color, and layout. This is a rule that is often hard to follow, because it is a rather elusive rule; however, given the relative simplicity of the TMC software tool, consistency will be fairly easily achieved.
2. **Enable frequent users to use shortcuts.** Interface design should include a way for experienced users to reduce the amount of time spent interacting with the program. For example, abbreviations, special key combinations or sequences, or macros may be optionally implemented for tasks that are expected to be performed on a regular basis.
3. **Offer informative feedback.** System feedback is important for all user interactions, and should be provided at a level appropriate to the magnitude of the action (or consequences of completion of the action).
4. **Design dialogs to yield closure.** Actions should have a beginning, middle, and end. Users should not be left wondering if they have completed a task, nor whether it is "safe" to continue to the next task.
5. **Offer error prevention and simple error handling.** Ideally, the goal should be to design a system where users cannot make serious mistakes and, if they do, they should be offered clear and informative instructions to recover.
6. **Permit easy reversal of actions.** In order to relieve anxiety and encourage exploration, users should be able to reverse (undo) actions if it is appropriate within the context to do so.
7. **Support internal locus of control.** Users should feel as if they are in control of the software, which responds to their actions – not the other way around.
8. **Reduce short-term memory load.** Information should be limited; keep displays simple by consolidating multiple page displays, and minimize the load on working memory by conforming the display to the immediate needs of the user.

Shneiderman, Ben. (1992). Designing the user interface: Strategies for effective human-computer interaction. Reading, MA: Addison-Wesley.

Appendix B Usability Evaluation Scenarios

This appendix provides the scenarios that will be completed by the tool evaluators. There are four scenarios in total. The scenarios cover the following topics:

- Inputting data into the tool
- Understanding and interpreting the tool output data
- Calculating relief factor for scheduling
- General tool features.

The scenarios begin on the next page.

TMC Staffing and Scheduling Tool: Inspection by Domain Expert

Evaluation Scenarios

The TMC Staffing and Scheduling Tool is intended to assist TMC managers in performing staffing workload analysis and making scheduling decisions. In order to effectively utilize the tool, specific information regarding work demand (often quoted in terms of the number of operators required in a specified period) must be determined for a specified TMC. While several methods exist for determining staffing levels in TMCs, a common practice is to conduct a demand analysis[3]. Normally, since the levels of demand for each TMC are unique to the traffic conditions of the area being managed by the TMC, a site-specific demand analysis would be performed prior to using the tool. However, for the sake of consistency in the evaluation being conducted, fictional work demand data is provided for use in the following evaluation scenarios.

The following scenarios were developed to step you through the process of interacting with the tool (using fictional TMC work demand data), and to ensure that you interact with all tool features. Please follow the steps for each scenario, and complete the related evaluation form at the end of each scenario. While completing the scenarios, please document any difficulties encountered. Please provide as much detail as possible on the provided *User Experience Log* form.

Please perform the following scenarios, and complete the *Domain Expert Evaluation Form* when finished. It is recommended that the evaluation form be filled out immediately after a scenario is completed, before continuing with the next scenario.

Scenario 1: Input data needed to create a generic weekly work schedule

While completing the tasks in this scenario, please document any difficulties encountered. Please provide as much detail as possible on the provided *User Experience Log*.

Opening the application…

1. When you are ready to begin, start your stopwatch.
2. Double click the file named "Staffing Tool.cmd"

Input the work hours for 3 shifts that cover a 24 hour period…

3. Select the checkboxes in the row for Shift 1 to have the shift cover an eight hour period from 4 am to Noon (hour 4 to hour 11). When you are finished, your Shift 1 input data should look like this:

4. Click the "Add" button **TWICE** to add the input rows for two more shifts.

[3] Demand analysis is a technique used to translate an anticipated pattern of work (e.g., level of congestion, volume of calls, number of accidents/emergencies, etc.) into work demands. The work demands are used to determine employee scheduling requirements.

5. Select the checkboxes in the row for Shift 2 to have the shift cover an eight hour period from Noon to 8 pm (hour 12 to hour 19).
6. Select the checkboxes in the row for Shift 3 to have the shift cover an eight hour period from 8 pm to 4 am (hour 20 to hour 24, hour 1 to hour 3).

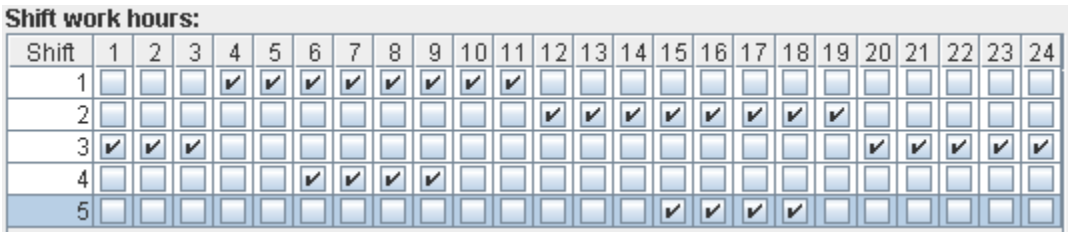
   Suppose a demand analysis was conducted on a TMC, and the results indicated that the following number of personnel were needed to provide adequate coverage for each hour in a 24 hour period over 7 days:

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Monday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Tuesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Wednesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Thursday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Friday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	4	4	3
Saturday	3	3	3	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	2
Sunday	2	2	2	2	2	2	2	3	3	4	4	4	4	4	4	4	4	4	4	3	3	3	3	2

   Input the number of on-duty operators that are needed to cover each hour…
7. Input the operator demand data (provided above) into the "Operators required by day and hour" table of the tool.

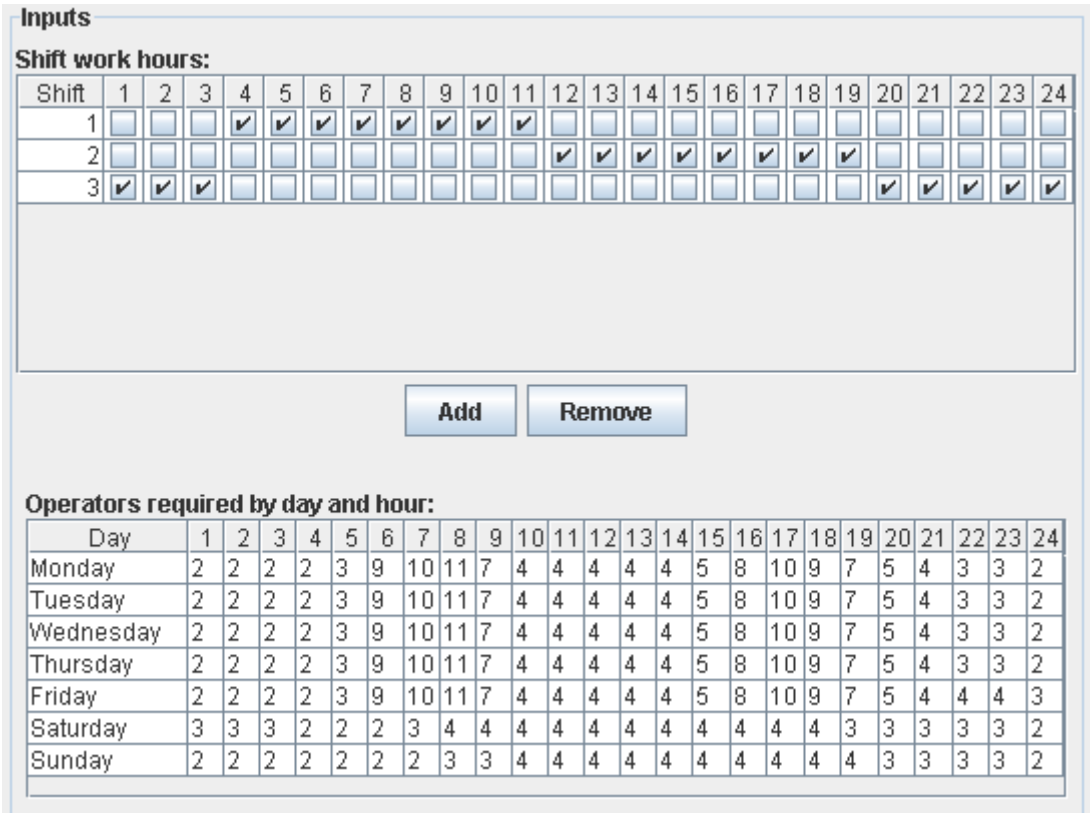
   Saving the scheduling input data to a file…
8. Click the button labeled "Save…" to save the input data as a comma-separated values (CSV) file.
9. Select a location for the file, and type the name "3shifts" for the file. A .csv extension will be automatically appended to the name. Write down or remember the location of this saved file.

   Loading and modifying a saved data file…
10. Close the application by clicking on the X in the upper right corner, and then re-open the application by double clicking on the file named "Staffing Tool.cmd"
11. Click the button labeled "Load…" and select the input data that was saved in the file named "3shifts.csv".
12. Add two more part time shifts (Shift 4 and Shift 5) to cover the morning and evening rush hours (hour 6 to hour 9 for Shift 4 and hour 15 to hour 18 for Shift 5):



13. Now, suppose you've changed your mind about having part-timers. Remove Shift 4 and Shift 5.
14. After you have removed Shift 4 and Shift 5, stop your stopwatch.

The input data that appears in your application should be identical to the figure below. Compare your input data to ensure that your data matches the sample data.



Inputs

Shift work hours:

Shift	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	☐	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☐	☐	☐	☐	☐
3	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑	☑

Add Remove

Operators required by day and hour:

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Monday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Tuesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Wednesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Thursday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Friday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	4	4	3
Saturday	3	3	3	2	2	2	3	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	2
Sunday	2	2	2	2	2	2	2	3	3	4	4	4	4	4	4	4	4	4	4	3	3	3	3	2

Complete the Domain Expert evaluator rating form for Scenario 1 before continuing with Scenario 2.

Scenario 2: Output created by the TMC Staffing and Scheduling Tool

While completing the tasks in this scenario, please document any difficulties encountered. Please provide as much detail as possible on the provided *User Experience Log*.

Calculating the shift schedule…

1. If you do not already have the input data loaded, load it now.
2. When you are ready to begin, start your stopwatch.
3. Click the button labeled "Calculate".

Interpreting the number of employees needed…

4. Examine the output data table labeled "Employees needed for each day and shift" until you are confident you understand and can interpret the output data.

Interpreting the number of employees starting a specific shift on a specific day…

5. Examine the output data table labeled "Employees by first day of work week and shift" until you are confident you understand and can interpret the output data.

Determining the number of hours where on-duty personnel exceeds demand…

6. Examine the output data item labeled "Excess hours per week" until you are confident you understand and can interpret the output data.

Determining the scheduling efficiency…

7. Examine the output data item labeled "Scheduling efficiency" until you are confident you understand and can interpret the output data.

Exporting the output data…

8. Click the button labeled "Export CSV…" to export the output data as a comma-separated values (CSV) file.
9. Select a location for the exported file, and type a name for the file. A .csv extension will be automatically appended to the name.
10. View the output data in a CSV-compatible application, such as Microsoft Excel, Notepad, or WordPad.
11. Stop your stopwatch.

Please complete the Domain Expert evaluator rating form for Scenario 2 before continuing with Scenario 3.

Scenario 3: Calculating the relief factor

While completing the tasks in this scenario, please document any difficulties encountered. Please provide as much detail as possible on the provided *User Experience Log*.

Calculating the relief factor…

1. When you are ready to begin, start your stopwatch.
2. Click the tab labeled "Relief Factor" at the top of the tool window.

Suppose the current staffing information for a TMC is as follows:

The total number of days-off for all operators in the TMC	723
The number of operators that are included in the days-off	36
The total number of operator work positions that need to be staffed	29

3. Input the relief factor information (provided above) into the editable (white) text boxes. The values in the non-editable (yellow) text boxes will be calculated by the tool.
4. Examine the relief factor output data until you are confident you understand and can interpret the output data.
5. Stop your stopwatch.

Please complete the evaluator rating form for Scenario 3, as well as the evaluator form for the general features of the tool.

Appendix C User Experience Log

This appendix provides a form that can be used by tool evaluators to document specific difficulties they may have with the software (e.g., not working as expected, not working at all, not liking the implementation, etc.), as well as any positive aspects of the software that they particularly liked. It is expected that evaluators would add entries to the form as they work through the evaluation scenarios. Evaluators are asked to document the scenario in which the issue was encountered, the step number in the scenario that most closely pinpoints the point in the scenario when the experience occurred, and a description of the difficulty or positive aspect encountered.

Information about difficulties will be used by the software developers to try to recreate the conditions under which the difficulty was encountered so that they can recreate the problems and rectify them if necessary. This information will also help the designers determine if a different implementation should be considered. Reports of positive experiences will be used to ensure that implementation changes do not inadvertently remove positive aspects from the design.

The user experience log form appears on the next page.

TMC Staffing and Scheduling Tool Evaluation – User Experience Log

Evaluator Name_____

Please describe any difficulties or positive experiences you had with the tool. Please provide as much information as possible; the software development team will need to know the details so that they can recreate problems to determine how to fix them. Use additional paper, as needed.

Scenario #	**Step #**	**Details of the Experience**	**Was this a Difficulty or Positive Aspect? (circle one)**
			D / PA
			D / PA
			D / PA
			D / PA
			D / PA
			D / PA
			D / PA
			D / PA
			D / PA

Appendix D Domain Expert Evaluation Form

This appendix provides the evaluation forms that will be used by the TMC evaluators.

The evaluation forms appear starting on the next page.

TMC Staffing and Scheduling Tool Evaluation

Evaluator Name_____
Facility_____
Position_____
Date_____

What operating system are you using for this evaluation?
_____ Microsoft Windows 2000
_____ Microsoft Windows XP
_____ Other (Please Specify) _____

Please explain any deviation from the minimum requirements requested for this evaluation _____

For this evaluation, each item is to be rated for satisfaction level on a scale of 1 to 4. Please use the following as a guide for assigning the ratings.

1 – Unsatisfactory	Difficult to use or inadequate content
2 – Marginally Unsatisfactory	Usable, but an alternative implementation or explanation would be considerably better
3 – Marginally Satisfactory	Minor suggestions for improvement
4 – Satisfactory	Happy with functionality and content

Evaluator Rating Form – Scenario 1 (Input Data)

Approximately how long did it take to complete the scenario? _____

Use the following scale to rate each item. Provide comments associated with content relevance, functionality, and visual appeal, including any suggestions for changes.

1 Unsatisfactory	**2 Marginally Unsatisfactory**	**3 Marginally Satisfactory**	**4 Satisfactory**
Evaluation Item	**Rating (1-4)**	**Comments**	
Overall Ease of Use			
Opening the application			
Designating work hours for a particular shift			
Adding shifts			
Removing shifts			
Saving an input data file			
Loading an input data file			
Time needed to complete all the data input that is required			
Layout and presentation			
Order of layout for input data requested (i.e., progression of defining work hours before defining operator demand)			
Clarity and meaningfulness of labels for input area (e.g., “Shift work hours” and “Operators required by day and hour”)			
Clarity and meaningfulness of column and row names for each input area			
Clarity and meaningfulness of button labels (e.g., “Add”, “Remove”, “Save”, “Load”)			
Relevance and usefulness of tool tip hints			
Overall appeal of layout and visual presentation			

Please provide any general comments you have regarding your interaction with the tool:

Evaluator Rating Form – Scenario 2 (Output Data)

Approximately how long did it take to complete the scenario? _____

Use the following scale to rate each item. Provide comments associated with content relevance, functionality, and visual appeal, including any suggestions for changes.

1 Unsatisfactory	**2 Marginally Unsatisfactory**	**3 Marginally Satisfactory**	**4 Satisfactory**
Evaluation Item	**Rating (1-4)**	**Comments**	
Overall Ease of Use			
Generating the output data			
Understanding and interpreting the data output for "Employees needed for each day and shift"			
Understanding and interpreting the data output for "Employees by first day of work week and shift"			
Understanding and interpreting the data output for "Excess hours per week"			
Understanding and interpreting the data output for "Scheduling Efficiency"			
Exporting the output schedule data to a .csv file			
Viewing the .csv file			
Layout and presentation			
Clarity and meaningfulness of labels for output area			
Clarity and meaningfulness of column and row names for each output area			
Clarity and meaningfulness of button labels			
Relevance and usefulness of tool tip hints			
Overall appeal of layout and visual presentation of output			

Please provide any general comments you have regarding your interaction with the tool:

Evaluator Rating Form – Scenario 3 (Relief Factor)

Approximately how long did it take to complete the scenario? _____

Use the following scale to rate each item. Provide comments associated with content relevance, functionality, and visual appeal, including any suggestions for changes.

1 Unsatisfactory	**2 Marginally Unsatisfactory**	**3 Marginally Satisfactory**	**4 Satisfactory**
Evaluation Item	**Rating (1-4)**	**Comments**	
Overall Ease of Use			
Inputting the data			
Understanding and interpreting the output			
Layout and presentation			
Clarity and meaningfulness of labels for input information			
Clarity and meaningfulness of the descriptions of the input data requested			
Overall appeal of layout and visual presentation of output			

Please provide any general comments you have regarding your interaction with the tool:

Evaluator Rating Form –General Tool Features

Use the following scale to rate each item. Provide comments associated with content relevance, functionality, and visual appeal, including any suggestions for changes.

1 **Unsatisfactory**	**2** **Marginally Unsatisfactory**	**3** **Marginally Satisfactory**	**4** **Satisfactory**
Evaluation Item	**Rating (1-4)**	**Comments**	
General			
Access to help materials or user manual for the tool			
Completeness of information requested in the input process			
Adequacy of the capabilities (features and functionality) of the tool			
Completeness of information generated in the output			
Usefulness of tool in enhancing current processes			

Please provide any general comments you have regarding your interaction with the tool:

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Note to Printer: This is the Spine Title

Transportation Management Center Staffing and Scheduling for Day-to-Day Operations
Tool Test Protocol

FHWA-OP-05-XXX