NASA/TM–2011-217164

The Multi-Attribute Task Battery II (MATB-II) Software for Human Performance and Workload Research: A User's Guide

Yamira Santiago-Espada
Langley Research Center, Hampton, Virginia

Robert R. Myer
Stinger Ghaffarian Technologies, Hampton, Virginia

Kara A. Latorella and James R. Comstock, Jr.
Langley Research Center, Hampton, Virginia

July 2011

NASA STI Program . . . in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA scientific and technical information (STI) program plays a key part in helping NASA maintain this important role.

The NASA STI program operates under the auspices of the Agency Chief Information Officer. It collects, organizes, provides for archiving, and disseminates NASA's STI. The NASA STI program provides access to the NASA Aeronautics and Space Database and its public interface, the NASA Technical Report Server, thus providing one of the largest collections of aeronautical and space science STI in the world. Results are published in both non-NASA channels and by NASA in the NASA STI Report Series, which includes the following report types:

- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counterpart of peer-reviewed formal professional papers, but having less stringent limitations on manuscript length and extent of graphic presentations.

- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.

- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.

- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or co-sponsored by NASA.

- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.

- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services also include creating custom thesauri, building customized databases, and organizing and publishing research results.

For more information about the NASA STI program, see the following:

- Access the NASA STI program home page at *http://www.sti.nasa.gov*

- E-mail your question via the Internet to help@sti.nasa.gov

- Fax your question to the NASA STI Help Desk at 443-757-5803

- Phone the NASA STI Help Desk at 443-757-5802

- Write to:
  NASA STI Help Desk
  NASA Center for AeroSpace Information
  7115 Standard Drive
  Hanover, MD 21076-1320

NASA/TM–2011-217164

The Multi-Attribute Task Battery II (MATB-II) Software for Human Performance and Workload Research: A User's Guide

Yamira Santiago-Espada
Langley Research Center, Hampton, Virginia

Robert R. Myer
Stinger Ghaffarian Technologies, Hampton, Virginia

Kara A. Latorella and James R. Comstock, Jr.
Langley Research Center, Hampton, Virginia

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

July 2011

Acknowledgments

The development of MATB-II was possible thanks to the hard work of the development team and the help of many others at the NASA Langley Research Center who contributed their time, talent, and allocated funding to make this project a success. Our appreciation is extended to colleagues who recorded the audio files, reviewed the Beta testing process, allowed us to use NASA facilities for these activities and reviewed the User's Guide. Among those are Lisa O. Rippy, Raymond S. Calloway, B. Danette Allen, Eric Cooper, Roger Bailey, Daniel W. Burdette, Samuel C. Hall, Alan T. Pope, Chad L. Stephens, Jennifer A. Inman, Kenneth H. Goodrich, Anna C. Trujillo, Patricia G. Cowin, Jeffrey S. Hill, Fernandus Rattliff, A. Terry Morris and Wilfredo Torres-Pomales.

The authors appreciate the work performed by many students involved in the development of MATB-II. Those people include Joshua Saltar, Jorge L. Herrera, Ryan R. Walker and Jacquelyn Gómez.

The feedback of the individuals and institutions that served as beta testers proved to be useful, as it led to improvements in the user interface and refinement of the application. Thanks to the testing groups of the U.S. Army's Aberdeen Test Center and the Air Force Research Lab, Wright-Patterson Air Force Base for their support.

Available from:

NASA Center for AeroSpace Information
7115 Standard Drive
Hanover, MD 21076-1320
443-757-5802

Table of Contents

Appendices

1 Introduction to the MATB-II User's Guide

The Multi-Attribute Task Battery (MAT Battery), a computer-based task designed to evaluate operator performance and workload, has been redeveloped to execute in Windows XP Service Pack 3, Windows Vista and Windows 7 operating systems. MATB-II comprises essentially the same tasks as the original MAT Battery, plus new configuration options including a graphical user interface for controlling modes of operation. MATB-II operates either in training or testing mode, as defined by the MATB-II configuration file. The configuration file also allows set up of the default timeouts for the tasks, the flow rates of the pumps and tank levels of the resource management (RESMAN) task. MATB-II comes with a default events file that an experimenter can modify and adapt to his/her needs. The events file is used to set up the communications and tracking sessions, generate state change events for the task components (such as pumps, lights and scales) and initiate the workload rating scale. Both the configuration and the events files are written in Extensible Markup Language (XML). MATB-II records the events presented to the subject, and the subject's responses when interacting with the tasks. Output files are created for each sub-task of the Battery. The MATB-II release contains documentation to aid in the creation of events files. It also includes a library of audio files for the communications task. Eighty different "ATC-like" auditory messages were recorded with four unique voices, and combined in 8 sets of 80 files in the Waveform Audio File Format (WAV). This technical memorandum introduces MATB-II and provides details on its installation, configuration, execution, and documentation. It serves as a user's guide and contains an extensive appendix that provides information on the features and operation of MATB-II.

1.1 About the MAT Battery

Approximately 20 years ago NASA released the Multi-Attribute Task Battery (MAT Battery) for the first time (Comstock & Arnegard, 1992). The MAT Battery, a DOS and early Microsoft Windows OS based open source platform for performing multi-task workload and human/automation interaction experiments, gained widespread acceptance among the research community. The MAT Battery has been used in many human performance studies associated with multitasking and the use of automation. Since its release, the MAT Battery software has been utilized in over 130 published research studies. The MAT Battery continues to be a useful research application, and has been employed in over 40 studies since 2003.

1.2 The New MATB

The MAT Battery was designed to run on operating systems available at the time it was created. MATB-II, a revised version of MAT Battery, has been developed to achieve a fully functional version of the MAT Battery on current operating systems. MATB-II was implemented in Visual Basic.NET and designed to operate on current versions of Microsoft Windows OS.

MATB-II includes similar tasks found in the original MAT Battery: the system monitoring task (SYSMON), the tracking task (TRACK), the communications task (COMM), and the resource management task (RESMAN). The scheduling window (SCHED), present in the MAT Battery, has also been re-implemented to provide a "look ahead" at the expected workload. Similar to the previous version, MATB-II provides an opportunity to collect post-experiment workload ratings based on the NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988). The MATB-II is intended to be operated by two types of users: the experimenter, who sets up experimental sessions using the application; and the subject, who interacts with the application during experimental trials and provides feedback about his/her performance.

This guide presents the features and functionality of MATB-II. It includes numerous screen captures that were taken while the application was being developed. MATB-II was evolving at the time this guide was prepared. Therefore, the readers might notice subtle differences between the screen captures shown herein and the software.

1.3 Hardware and software requirements

MATB-II is a 32-bit .NET Framework 4.0 application designed to be run on Microsoft Windows XP SP3 or newer operating systems (MS Vista or Windows 7). Though MATB-II requires a mouse for most of the tasks, arrow and function keys can also be used. The tracking task requires a joystick, and the communications task requires that the computer have sound capabilities. It is necessary to have speakers or headphones connected to the computer. Because the system performance is affected by the central processing unit (CPU) speed and random access memory (RAM) size, MATB-II should be installed on a computer that exceeds the minimum CPU and memory requirements to run its own operating system.

MATB-II uses Direct X for the joystick and Hotkey to capture the function keys. The MATB-II setup program installs the following Dynamic Link Library (DLL) files: HotkeyControl.dll, Microsoft.DirectX.dll and Microsoft.DirectX.DirectInput.dll. Once installed, these files are stored in the \MATB folder of the main computer drive. If those DLL files are not in the search path[1] of the computer they will need to be copied in the \MATB folder of the main drive on the computer.

1.4 About using Video Capture

Using screen capturing software concurrently with MATB-II might slow down its operation. If the experimenter desires to use a screen recorder (e.g. Camtasia Studio, CamStudio Open Source, FrontCam, etc.) or other concurrent applications,

[1] The route followed by an operating system to find the location of a stored file. The search path begins with a drive or volume (disk) designator or a network share, continues through a chain of directories and subdirectories, if any, and ends with the file name. C:\books\diction\start.exe is an example of a search path. Also called: access path

he/she should conduct testing to ensure that the computer has enough CPU speed, graphics processing speed and memory to support all the applications operating simultaneously. To keep the software timing as close to the system clock as possible, a .Net Stopwatch object is used to synchronize the MATB II 'Elapsed Time' with the computer's system clock.

1.5 MATB-II Section Guide

A summary of the contents of the MATB-II user's guide is illustrated by the flowchart in Figure 1-1, and described below.

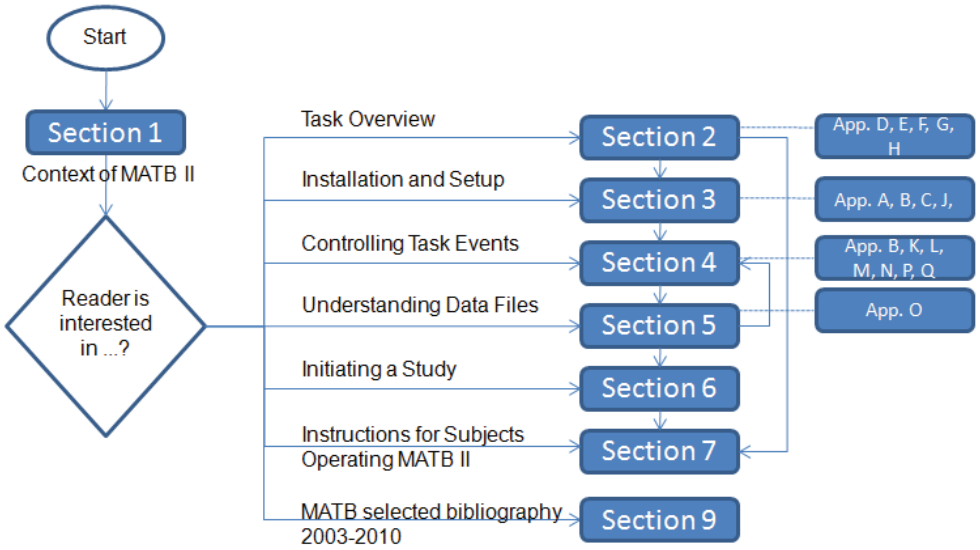


Figure 1-1. Reader Flowchart for the MATB-II User's Guide

Section 1 provides information about the re-implementation of the MAT Battery. Section 2 introduces the MATB-II tasks and notes differences between the MAT Battery and MATB-II. Sections 3 – 6 explain how to set up and run an experiment using MATB-II, as well as how to understand the output data files generated after the MATB-II session. Section 7 provides the information to make a subject familiar with the tasks of MATB-II. Section 9 provides a reference list of published research works that have used the MAT Battery from 2003 to 2010. Appendices A-J contain a guide that describes in depth the operation of MATB-II.

Appendix K introduces the MATB Documentation Compiled HTML file. Appendix L explains how to generate events in the MATB-II and provides the experimenter with worksheets, templates and lists that will aid in the creation of the Events file. Appendices N, P and Q provide additional information on the Events File. Appendices M and Q guide the experimenter in creating the Audio Scripts for the communications task. Appendix O lists a sample MATB-II output data file.

2 Task Overview

From an experimental subject's perspective, MATB-II is very similar to the MAT Battery. The tasks of MATB-II are generalizations of piloting tasks, and events associated with those tasks are presented to subjects as prescribed in an experimenter-defined script called MATB_Events.xml, and referred to as the "Events file". The construction of the events file is further described in Section 4, "Control of Task Events".

The tasks of MATB-II are the system monitoring (SYSMON), tracking (TRACK), communications (COMM) and resource management (RESMAN). A scheduling (SCHED) display allows the subjects to "look ahead" at their expected workload. Borders can be enabled to separate the areas (panels) pertaining to each task of the MATB-II main window. (Figure 2-1).

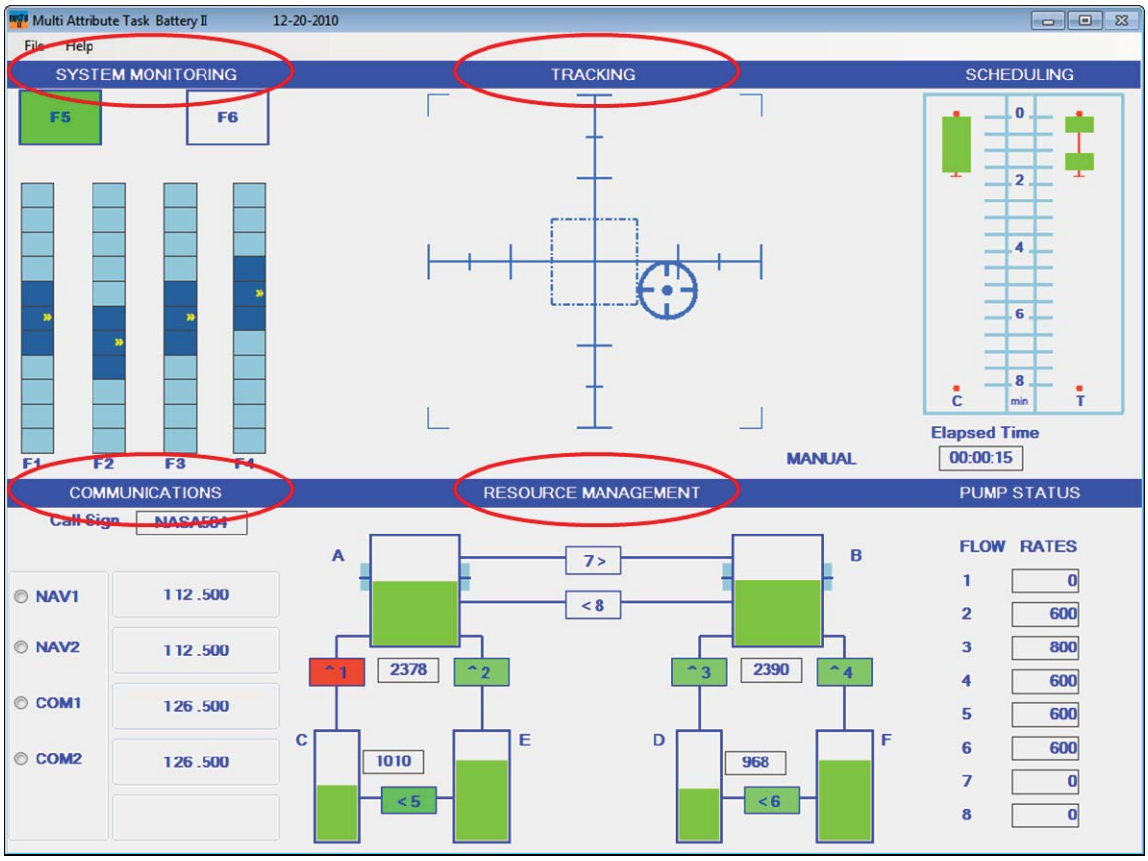


Figure 2-1. The tasks for the Multi-Attribute Task Battery II

The tasks of MATB-II will be described in sections 2.1 to 2.6, along with the variations in the MATB-II tasks with respect to the original MAT Battery (Section 2.7).

2.1 System Monitoring Task

The SYSMON task appears in the upper left corner of the MATB-II main window and is divided into two sub tasks: warning lights and scales. The warning lights are represented by two boxes in the upper portion of the panel (Figure 2-2). During a run, the light on the left is normally green, indicating an “On” condition. The subject is required to detect and respond to the absence of this light (when it turns from green to the background color) by clicking on it with the mouse, or by pressing the “F5” key. Clicking on the light will turn it back “On” (i.e., lit green). The light on the right is normally “Off” (background color). However, when it turns “On”

(red), the subject should respond by clicking on it with the mouse, or by pressing the “F6” key, which turns it “Off” again (background color). The experimenter will decide if the mouse or a keyboard method is preferred, or if it doesn’t matter which method to use.

The second part of the SYSMON task involves four scales; each scale has an “indicator light” (represented by a segmented bar graph) which moves up and down independently on each scale. The indicator lights normally fluctuate around the middle of the scale. The subject’s task is to detect when the lights shift their position away from the middle of the scales and respond by clicking on the scale whose lights shifted up or down (Figure 2-2). The subject can also respond by pressing the function key indicated below the affected scale.

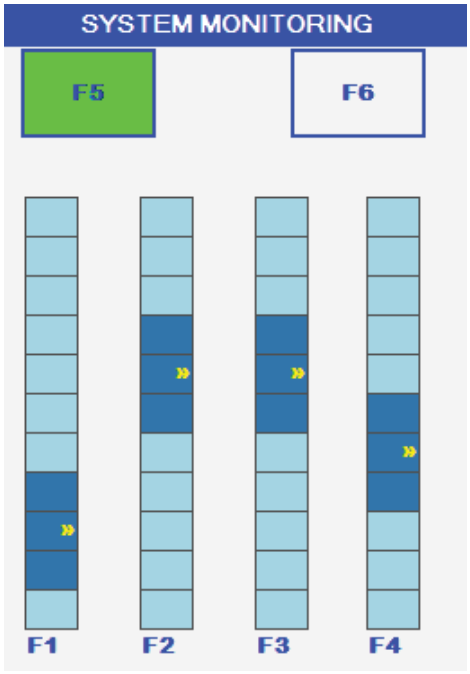


Figure 2-2. The System Monitoring task

While the subject performs the SYSMON task, MATB-II records the time at which the event was processed and the name of the sub-task in the main output file (e.g. MATB_yyyy_mmddhhmm.txt). The file name of the MATB output file contains

date and time information. In addition, MATB-II records subject response or lack of response information in the SYSMON output file (e.g. SYSM_yyyy_mmddhhmm.txt).

Through the MATB_EVENTS.xml file the experimenter can control the state changes of the lights and the scales. Section 4.2.4 explains how to set up the XML entries to generate SYSMON events.

2.2 Tracking Task

The TRACK task is in the upper center panel of the MATB-II main window. This task operates in either manual (MANUAL) or automatic (AUTO ON) mode. The current mode is indicated by an annunciator in the lower right of the TRACK region (Figure 2-3). In the manual mode, the subject uses the joystick to keep the target in the center of the inner box. The target center point will fluctuate and remain in the inner box when the task is in *automatic* (AUTO ON) mode (Figure 2-3). When the task changes mode to *manual* (MANUAL), the target goes outside the box, and the subject will be required to use the joystick to re-center the target. Scripted “automation failure” events cause the target to move outside the target zone and the mode to switch from automatic to manual.

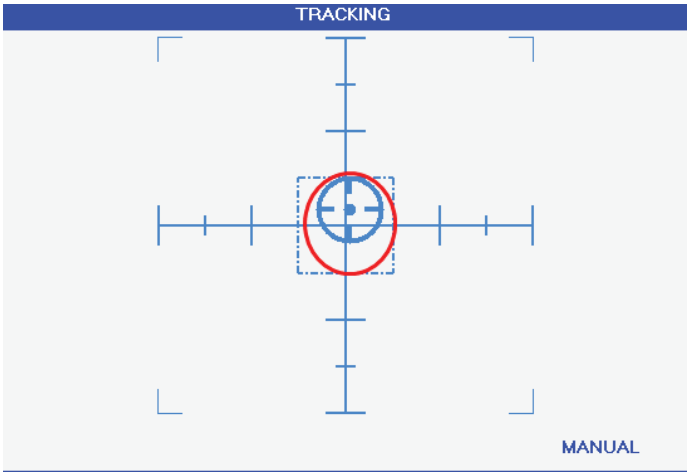


Figure 2-3. Tracking Task – target inside desired area

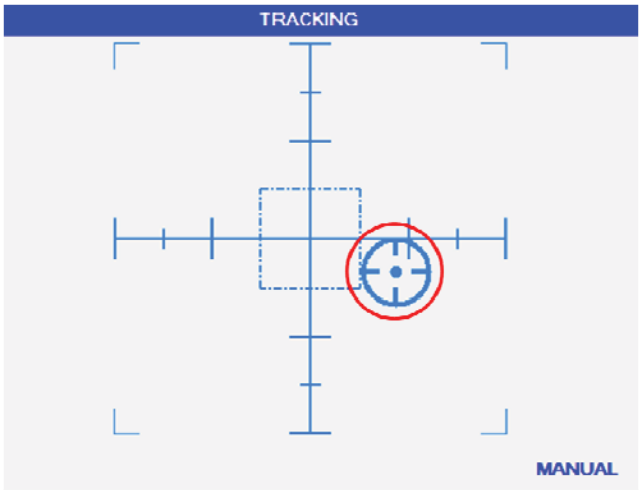


Figure 2-4. Target outside desired area

The experimenter can use the MATB_EVENTS.xml file to make MATB-II transitions from the automatic mode to the manual mode and vice versa. When in manual mode, MATB-II acquires sample data of the target center position relative to the grid center point. MATB-II calculates the root mean square deviation of the target center point from the center point in pixel units (RMSD-C) at a predetermined time interval. By default, MATB-II will record and register the joystick data to the proper output files each 15 seconds. The experimenter can change the recording interval through the Set Run Parameters (SetRunParam) window or by editing the MATB_Config.xml file.

To learn more about the SetRunParam and the MATB_CONFIG.XML file, see Sections 3.3 and 4.1 of this User's Guide. Section 3.3 introduces the SetRunParam window and Section 4.1 explains the elements of the MATB_CONFIG.XML file.

2.3 Scheduling Display

The upper rightmost panel of MATB-II contains the Scheduling Display (Figure 2-5). It provides a "look ahead" view for COMM task sessions and TRACK task Manual/Automatic modes. SCHED allows the subject to "look ahead" for up to

eight minutes in the future at activity of the tracking and communications tasks. The scheduling display shows the beginning and/or ending (and duration) of these two tasks from 0.0 minutes (present) to 8.0 minutes into the future. The green bar indicates the time during which the COMM session is active and the TRACK task is in manual mode. At other times the green bar graph is replaced by a red thin line. The red thin line indicates times at which the subject will not need to attend to the COMM and the TRACK tasks. SCHED also shows the elapsed time of a session run in the lower left of the panel. SCHED displays when MATB-II is scheduled to stop execution by showing perpendicular intersecting lines at the end of the thin red lines. The thin red lines do not extend beyond the time at which MATB-II is scheduled to stop execution. Figure 2-5 illustrates a run with tracking and communications events taking place over the next two minutes, and with an elapsed time of 6 seconds. The SCHED displays that a COMM session already started, and the TRACK task is currently in manual mode. There is a second TRACK manual session in the 'look ahead' view.

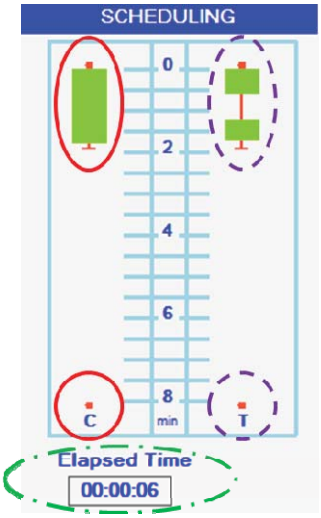


Figure 2-5. The Scheduling Display

The SCHED display is not a task that requires subject intervention. The content and dynamics of this display are prescribed by the scripted events for the COMM and TRACK tasks. SCHED only provides "look ahead" information so there

is no data recording associated with it. However, when each COMM session starts or ends, an entry is made in file MATB_yyyy_mmddhhmm.txt. This is also the case with transitions between TRACK AUTO ON and MANUAL modes.

MATB-II uses an elapsed timer counter that is running, unless the user interacts with the Workload Rating Scale, selects a menu item of MATB-II, or activates another process or application, such as Microsoft Word.

The elapsed time is included in all data recordings as a reference. MATB-II records output data to a number of different output files. Those files are: the MATB_yyyy_mmddhhmm.txt file, which registers the initiation and termination of the events; the SYSM_ yyyy_mmddhhmm.txt file, for SYSMON; the TRCK_ yyyy_mmddhhmm.txt file, for TRACK; the RMAN_ yyyy_mmddhhmm.txt file, for RESMAN; the COMM_ yyyy_mmddhhmm.txt file, for COMM; and WRS_ yyyy_mmddhhmm.txt file for the Workload Rating Scale. By default, MATB-II saves the output files in the \Data subfolder of the directory where MATB-II is installed.

2.4 Communications Task

During a run there may be one or more “COMM sessions” where the subject listens for messages (like air traffic control requests) to change the frequency of a specific radio. This COMM task (Figure 2-6) is located in the lower left region of the MATB-II main window. The air traffic control requests take the following form: {aircraft call sign} (which is repeated) “tune your” {radio} “radio to frequency” {frequency}. The possible values for the {radio} field are COM1, COM2, NAV1 and NAV2. Table 4-4 in Section 4.2.7 provides the range of frequencies used by MATB-II’s COMM task.

Similar to an aviation context, not all of the messages used in the COMM task pertain to the subject. A subject only responds to messages intended for his/her “aircraft” which uses the aircraft call sign of “NASA504” (shown in Figure 2-6).

When the message is intended for “NASA504” the subject’s task is to change the frequency on the assigned radio”. No action is required of the subject for messages to call signs other than his/her “own.”

An example COMM message to which a subject would respond is: “NASA five zero four, NASA five zero four, tune your com one radio to frequency one two eight point four seven five”. In this instance, the subject would change the frequency of the COM1 radio to 128.475. An example instruction for another aircraft that the subject should ignore would be: “Fedex three zero three, Fedex three zero three, tune your nav two radio to frequency one one one point nine five zero”.

Figure 2-6. COMM task with COM2 radio selected

In order to change a radio frequency, the subject first selects a radio. Once a radio is selected, MATB-II enables the frequency change arrows for that particular radio, and the ENTER button becomes visible. The subject can click on the arrows to set the frequency and then press the ENTER button when done selecting the

frequency. These controls to change the frequency are only visible when the event is active. They also disappear when a frequency change is processed by selecting the COMM task ENTER button. The subject can also press ‘Ctrl' and keyboard arrows, and 'Alt' and keyboard arrows to change the integer and decimal portions of the frequency, respectively.

The experimenter can use the MATB_EVENTS.xml file to cause MATB-II to play an audio file that will instruct the subject to tune one of the COMM task radios to a specific frequency. By becoming familiar with the valid range of frequencies available for the COMM task (as explained in Section 4.2.7), the experimenter can generate a communications event. The experimenter can choose to use the audio files provided in the Audio File Library of the MATB-II, or create his/her own audio files for use in the COMM Task. The Section “Multi-Attribute Task Battery (MATB) Communications Task Audio Scripts and Filenames” (Appendix Q) provides more information on how to create and format the in Waveform Audio File Format (WAV) messages.

When a COMM event takes place, MATB-II records in the MATB_yyyymmddhhdd.txt output file the time of occurrence of the event and whether the instruction was directed to the“NASA504” or another aircraft. MATB-II also records in the COMM_yyyymmhhddmm.txt output file the following information: the radio and the frequency that the subject was instructed to tune to (target radio and target frequency), the radio and the frequency that the subject tuned to, and an indication of whether or not a subject tuned the radio and frequency correctly.

MATB-II uses the sound capability installed in the computer to produce audio for the COMM task. It is necessary to have speakers or headphones connected to the computer. The audio files of the COMM task are in WAV (Waveform Audio) format and MATB-II plays them using the Windows Media Player Sound Player API. It is recommended that the experimenter confirm that WAV files can be played on the computer system prior to installing MATB-II.

2.5 Resource Management Task

The RESMAN task is located in the bottom center of the MATB-II main window. The resource management task (Figure 2-7) depicts a generalized fuel management system.

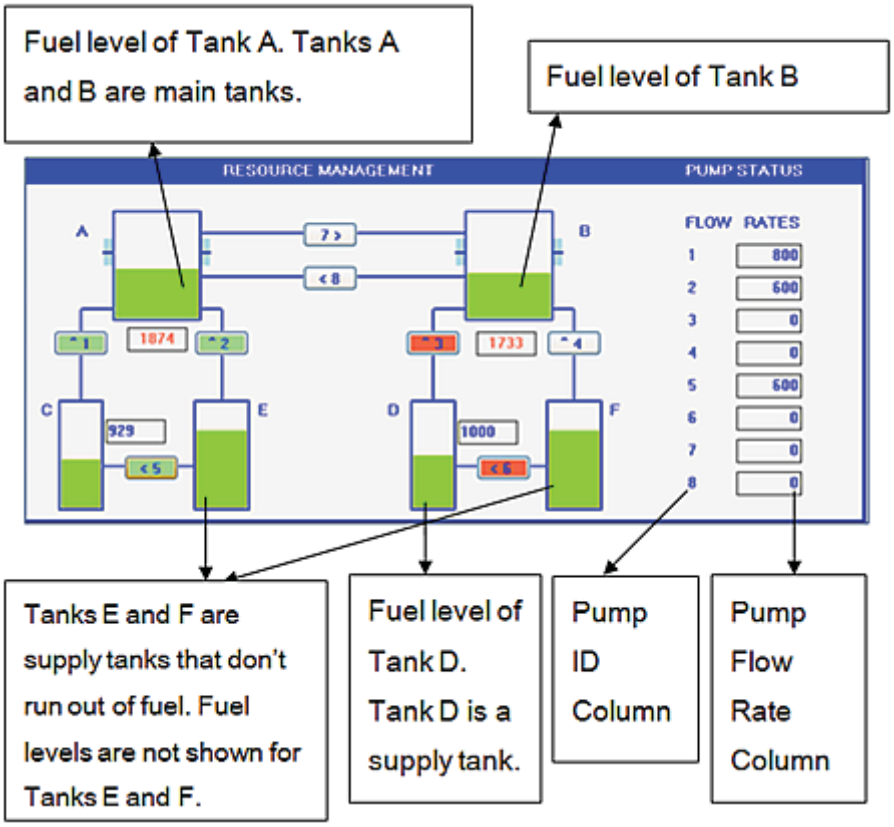


Figure 2-7. The Resource Management Task

The areas labeled A through F represent fuel tanks. The green levels within each tank represent the amount of fuel in that tank. Pumps, labeled 1 through 8, are located on the fuel lines which connect the tanks. The numbers adjacent to the tanks A-D represent the amount of fuel remaining in those tanks. The fuel level in the tanks is affected by the fuel consumption and by the actions that the subject performs on the pumps. Values for the fuel level are updated every 2 seconds as the amount of fuel in the tanks increases or decreases. The capacity of tanks A and B is 4000 units and for tanks C and D, the capacity is 2000 units. The two "supply" tanks, E and F, have an unlimited capacity.

The requirement for this task is for the subject to maintain the level of fuel in tanks A and B within ±500 units of the initial condition of 2500 units each. The target is to maintain 2500 units in these tanks with an acceptable target range, shown as a shaded area on the outside of each tank. The volume of the tanks is shown in black text when the tank level is within the acceptable range and with red text when the tank level is above or below the target range. The pump capacities are also configurable, and each pump has a default value.

In order to maintain the task objective, subjects must transfer fuel from the lower supply tanks to tanks A and B. Fuel is transferred through the use of the pumps. To activate a particular pump, the subject clicks the pump's labeled rectangle with the mouse, or presses the number of the pump on the keypad. Clicking on the pump or pressing the key a second time toggles that pump off. Each pump transfers fuel in the direction indicated by the arrow on its label.

The pump status is indicated by the color of the pump. When a pump is green, that pump is operational and actively transferring fuel (ON state). When the pump color matches the background color of the main window, the pump is operational, but is deactivated (OFF state). When the pump is red, the pump is not operational and may not be turned on (FAILED state). Figure 2-8 shows that the volume of both tanks A and B is below the target range. Note that the level line is below the target indicator and the volume is displayed with red text; pumps 3 and 6 are FAILED; pumps 1, 2, and 5 are ON; and pumps 4, 7 and 8 are OFF. In the scenario illustrated by Figure 2-8, fuel may be added to tank B with pumps 4 and 7; however, the volume of tank B will only increase if the contribution from these two pumps exceeds its consumption. In addition, since tank A is also below the target range, transferring fuel from tank A to tank B may not be a successful strategy.

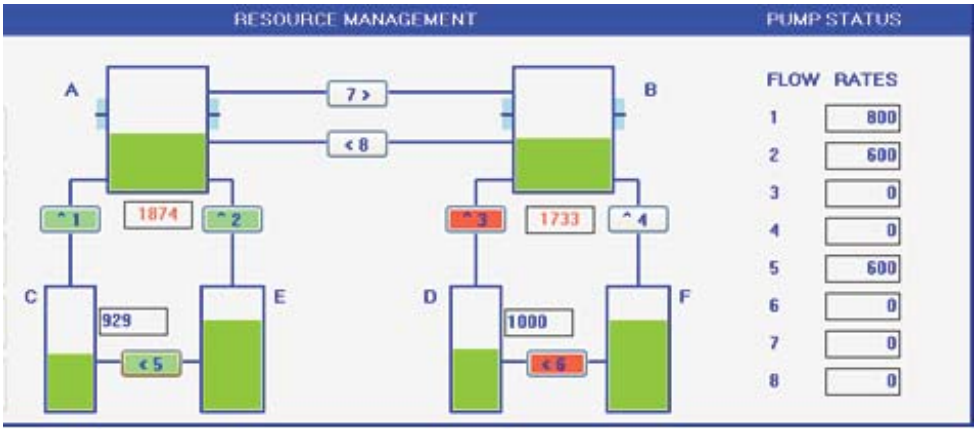


Figure 2-8. MATB-II executing RESMAN Pump Fail events

In Figure 2-8, the flow rates for each pump are presented under the "Pump Status" column, located to the right of the RESMAN area. The left column under the “Flow Rates” label, contain the pump ID numbers. When a pump is ON, its flow rate is represented next to the pump number in the right column under the “Flow Rates” label. When a pump is OFF, its flow rate is zero.

As with the consumption rates for tanks A and B, the pump flow rates are configurable. The default values in units per minute are

PUMP_1 = 800; PUMP_2 = 600; PUMP_3 = 800; PUMP_4 = 600;
PUMP_5 = 600; PUMP_6 = 600; PUMP_7 = 400; PUMP_8 = 400;
TANK_A = 800; TANK_B = 800.

The experimenter may select different rate values within the range 0-1000 units per minute through the MATB_CONFIG.XML file, as shown in Section 4.1.1. They may also be defined through a dialog window if using the SetRunParam mode (see Appendix for details).

MATB-II records the pump states (ON or OFF) and the tank levels at a specific recording interval set by the experimenter through the MATB_CONFIG.XML file (Section 4.1.1) or the Set Run Parameters startup window

(shown in Figure 3-12, Section 3.3). The default value for the recording interval is 30 seconds. That means that each 30 seconds, MATB-II registers the tank volumes and pump states data in the proper output file.

The mode of operation of the RESMAN task in MATB-II varies from the MAT Battery. In the MAT Battery, the RESMAN task could operate in the automatic mode. The automation of the RESMAN task is not implemented in the release version of MATB-II. In MAT Battery, the pumps were represented by rectangular boxes. In MATB-II, the pumps are implemented by buttons. The location of the labels for the pumps has changed in MATB-II. In the MAT Battery the labels that show the fuel capacity of Tanks C and D were placed under the tanks. In MATB-II the labels that show the fuel capacity of Tanks C and D are placed to the right of tanks C and D. The labels of the pump number and the arrow appear inside the pump, and not outside it, as it was done in the MAT Battery.

2.6 Workload Rating Scale

When specified by the script file, the Workload Rating Scale (WRS) based on the NASA-TLX (Hart & Staveland, 1988) appears in a full window (Figure 2-9). When the WRS is active, the run elapsed timer is paused until the subject either saves the ratings or the scripted presentation time for that screen is reached. Once the WRS ends, the run elapsed timer resumes.

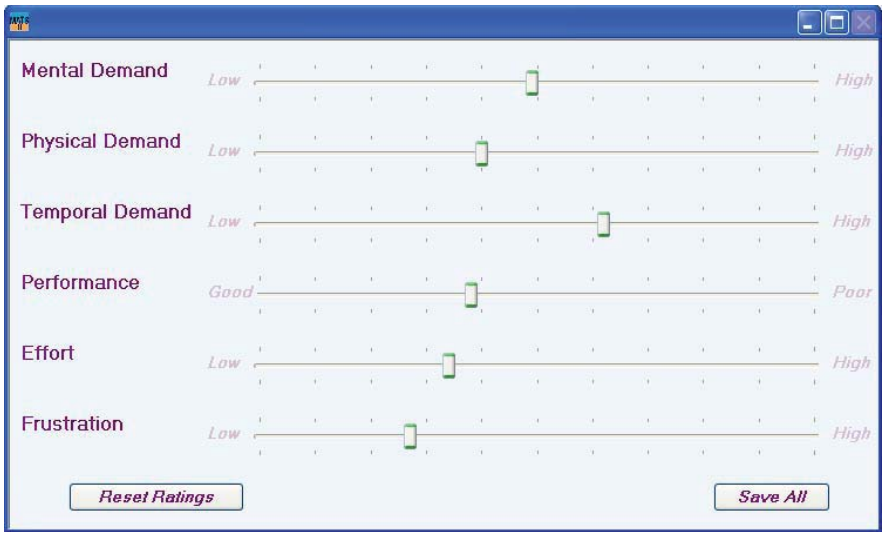


Figure 2-9. The Workload Rating Scale (WRS) is based on the NASA-TLX

In MATB-II, the WRS uses sliders to rate the workload. When the WRS initiates, the sliders are positioned at the center of the range of the subscales. Using the mouse, the subject changes the positions of the sliders in order to select the rating value. Once the subject is done with all the scales, the program will enable a "Save All" button in the same window. MATB-II does not enable the "Save All" button unless the subject moves the sliders of all the subscales.

Through editing the MATB_EVENTS.xml file or by using the SetRunParam window, the experimenter controls the time at which the TLX is presented and how long the rating scale is displayed.

2.7 Summary of Differences between the MAT Battery and MATB-II

In order to produce a version of the MAT Battery that executes in modern day operating systems, a new implementation was created. This version of the MAT Battery, while retaining the original tasks and the WRS based on the NASA-TLX, is not an exact duplicate of the original.

Notable differences in MATB-II are: a redesigned graphical user interface in keeping with current Windows appearance, configuration through XML scripts

instead of scripts written in plain text format, and changes in formatting and presentation of the post-experiment data of the output files. The MATB-II release does not presently contain an equivalent version of the APPLYWT and AFTERMAT programs that accompanied the MAT Battery. Those programs were used to obtain rating scale weightings and applying the weights to the data files generated during an experimental session.

The original MAT Battery worked on MS-DOS or early versions of MS Windows operating systems (Windows 3.0/3.1, Windows 95 and Windows 98 First Edition). MATB-II is designed to work in Windows XP SP3, Windows Vista, and Windows 7 in 32-bit mode. MATB-II uses the computer's sound capability, and uses a USB joystick.

The original MAT Battery defaulted to a black background, known as "Negative Display Face", but during setup the researcher could choose other colors from among a palette of 64 colors. MATB-II uses a Positive Display Face with colors chosen from the 216 Web-Safe Color Palette.

The SYSMON scales in the original MAT Battery showed a small yellow rectangle at the base of the scale when a correct response was made, confirming a correct input. Data were recorded for all subject inputs to the task even if a signal was not present. MATB-II does not give visual feedback of the performance of the subject in the scales; however, the program registers the mouse actions in the output data file for the SYSMON task, with an indication of whether the subject response was correct or not.

The appearance of the scales implemented in MATB-II is also different, as the graphical design for the level indicators of the scales has changed. In the MAT Battery, the scales had tick marks, and arrows that moved up and down. In MATB-II the scales are implemented as range bar graphs with the normal state position

randomly moving within the center portion of the entire range. In the non-normal state the range is either shifted above or below the normal state. While the MAT Battery used a sine wave function to determine the offset of the scales, MATB-II uses independent random number generators to select the position of each scale.

The area of the screen for the tracking task for the original MAT Battery was rectangular. MATB-II uses a square two-axis grid. The TRACK task in the MAT Battery used the sum of multiple sine wave functions for the X and Y dimensions with a 3:4 phase relationship to create the path the TRACK target would follow. With no input from the subject, a 3:4 Lissajous[2] figure would be traced on the screen (with adjustable gain). This sufficiently complex movement gave the appearance of a random target movement within the TRACK task. MATB-II uses a random number generator to determine target movement. Three update rates -low, medium and high- are available so target movement may differ for different manual mode requirements. In addition to the labeling, whenever the mode changes between the auto and manual modes, the grid of the TRACK task changes color from a lighter shade of blue to a darker shade of blue.

The representation of the SCHED Display in MATB-II varies from the original MATB. In the MAT Battery, the tick marks and numbers of the scale were located on the left of the display. In MATB-II, the tick marks and numbers are located in the center of the display. In the MAT Battery, the elapsed timer and the date of the run appeared under the system monitoring task. MATB-II's SCHED Display shows the Elapsed Timer and the date is displayed in the title bar.

In the MAT Battery the radio/navigation frequencies were displayed to the nearest 0.1 MHz (e.g., 117.8), a simplification of actual radio frequency displayed

[2] A Lissajous pattern is the looping patterns generated by a Cathode Ray Tube spot when the horizontal (X) and vertical (Y) deflection signals are sinusoids. The Lissajous pattern is useful for evaluating the delay or phase of two sinusoids of the same frequency.

resolution. In MATB-II, the actual Civil Aviation VHF (Very High Frequency) bands and frequency increments for both navigation and communication radios are used.

To support radio frequency change instructions, MATB-II contains an audio file library which can be programmed for use in the COMM task. This audio file library consists of eight sets of 80 WAV files each. These WAV files were recorded by four different individuals to allow for variety when scripting ATC messages. Four of the sets consist of all 80 instructions made by one of the individuals and the other four contain a mix of 20 from each individual. The Section “Multi-attribute Task Battery (MATB-II) Communications Task Audio Scripts and Filenames” (Appendix Q) provides instructions on how to produce air traffic control instructions with different individuals.

In the MAT Battery, when RESMAN operated in the AUTO mode, no subject intervention was required for turning the pumps on and off. The automation of the RESMAN task is not implemented in the release version of MATB-II.

There is a variation from the original MAT Battery in how the subject interacts with the Workload Rating Scale of MATB-II. In the MAT Battery, the subject was required to make scale inputs from top to bottom; in MATB-II, the subject can choose to rate the scales in the order he/she desires and save the responses once finished rating, or reset the responses and start the rating again.

The MAT Battery included a program (MATSET) that allowed the experimenter to select, read and convert the script files to be used by the MAT Battery. These script files were ASCII text based. MATB-II uses two XML scripts that define the way that MATB looks and executes. Those scripts are the configuration file (MATB_CONFIG.xml) and the events file (MATB_EVENTS.xml). MATB_CONFIG.xml contains a series of modes that provide capabilities that may be desired during experiment design and testing, or subject training that may not be

desired during data collection runs. Examples are 'Set Run Parameters' and 'Select Eventsfile' modes. The SetRunParam mode allows for configuration of flow rates of RESMAN and task timeouts at the beginning of the test. The Select Event Window allows the selection of a specific event, rather than the default events file which is MATB_EVENTS.xml. Through the AUTO_START mode, the experimenter can decide whether to set MATB-II to start the experimental session automatically, or set it to wait until the subject initiates it.

In the MAT Battery the experimenter controlled the timing and the sequencing of the tasks using a script consisting of a single ASCII text line for each event. For example, to raise Scale #3 up at time 00:22:19 the instruction was written as following:
0 22 19 SCALE 3 UP

In MATB-II, the events follow the XML syntax which is based upon tags, elements and attributes. The corresponding lines of code to raise Scale #3 up at time 00:22:19 is illustrated in Figure 2-10.

```
<!-- SYSMON SCALES  -->
<!-- System Monitoring - Move SCALE THREE UP  -->
<event startTime=" 0:22:19 ">
  <sysmon>
     <monitoringScaleNumber>THREE</monitoringScaleNumber>
     <monitoringScaleDirection>UP</monitoringScaleDirection>
   </sysmon>
 </event>
```

Figure 2-10. XML Entries for a SYSMON Scale Three UP Event

In the MAT Battery, the experimenter could either keep the data files in uniquely identified files, with the filename based on current date and time or create "test" data files for (checkout purposes) which were overwritten with a subsequent test run. In MATB-II, all output files have the same "year_month-day-hour-minute" suffix corresponding to the start time of the MATB-II session that they correspond to

(e.g. the suffix for the name of an output file generated at 7:55 AM on December 7, 2010 would be _2010_12070755).

A standalone “AFTERMAT” program accompanied the MAT Battery in order to establish the weightings for the Workload Rating Scale. The “APPLYWT” program was used to apply ratings scales obtained through “AFTERMAT” to the appropriate weighting and data files. While MATB-II implements the Workload Rating Scale based on the NASA TLX scales, the weighting comparisons and algorithm is not yet implemented.

MATB-II allows the configuration of the menu items, based upon the modes selected in MATB_CONFIG.xml. Its GUI features facilitate testing of the joystick and the sound capabilities of the computer, as well as setting up the tasks for training subjects in the proper operation of the MATB-II. When the experimenter enables the Train mode in the configuration file, MATB-II displays a “Train” menu. This menu includes options for listening to a sample of utterances used in the COMM task and interacting with the Workload Rating Scale. In a similar fashion, if the experimenter enables the Test mode of MATB-II, features like performing an audio test and a joystick test will be available as part of the “Test” menu. Section 3.5 gives a detailed explanation on the MATB-II modes of operation.

3 Installation and Setup

3.1 Installation

Prior to installing the MATB-II, the user should refer to the ReadMeFileFirst.txt file located in the main folder of the MATB Release and learn about the contents of the release package, its file structure, and the construction of the MATB_CONFIG.xml and the MATB_EVENTS.xml files. The user should review the contents of the MATB-II release package to get familiarity with the Audio File Library and other tools that are not automatically installed in the "\MATB" directory through the MATB-II setup process described below.

In order to install the application, it is necessary to access the MATB folder and locate the "\Install" directory.

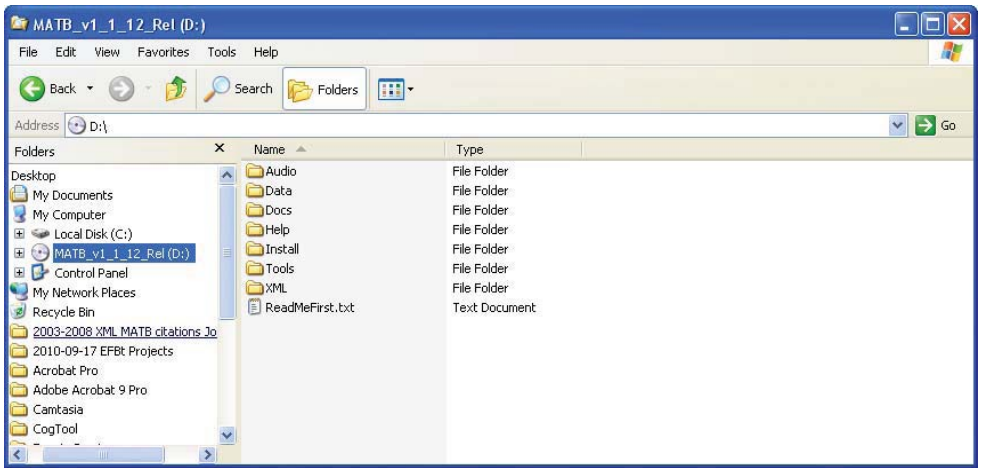


Figure 3-1. Locating the "\Install" folder in the MATB directory

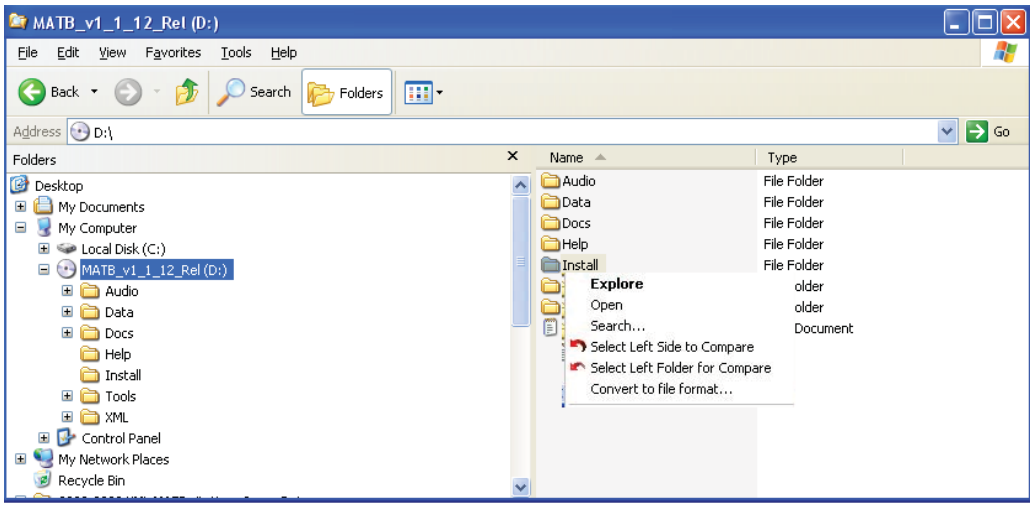


Figure 3-2. Expand the “MATB_v_1_12_Rel” Directory

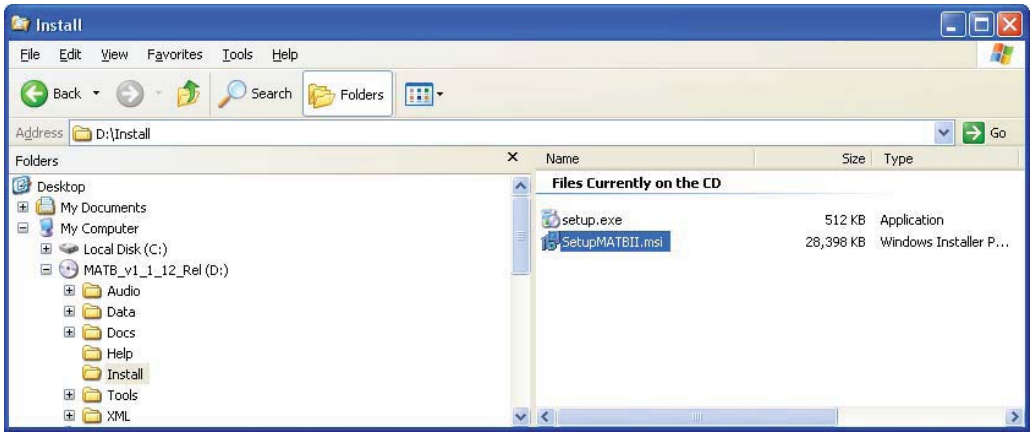


Figure 3-3. Expand the “\Install” directory

After expanding the “\Install directory” (Figure 3-3), double click *SetupMATBII.msi* to begin the installation (Figure 3-4) and follow the directions on the dialog boxes that appear. If desired, accept the default settings in the dialog boxes and click “Next” (Figure 3-5).

Figure 3-4. Select the “Next” button at the “Welcome” screen

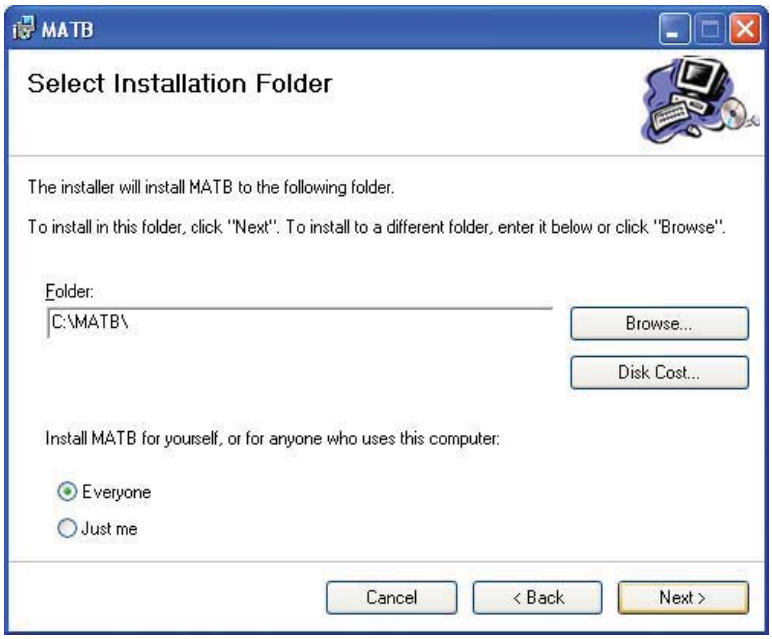


Figure 3-5. If desired, accept the default values and click the “Next” button

Select “Next” after viewing the Installation Confirmation Screen (Figure 3-6). The installation will display a progress screen while it installs the application (Figure 3-7).

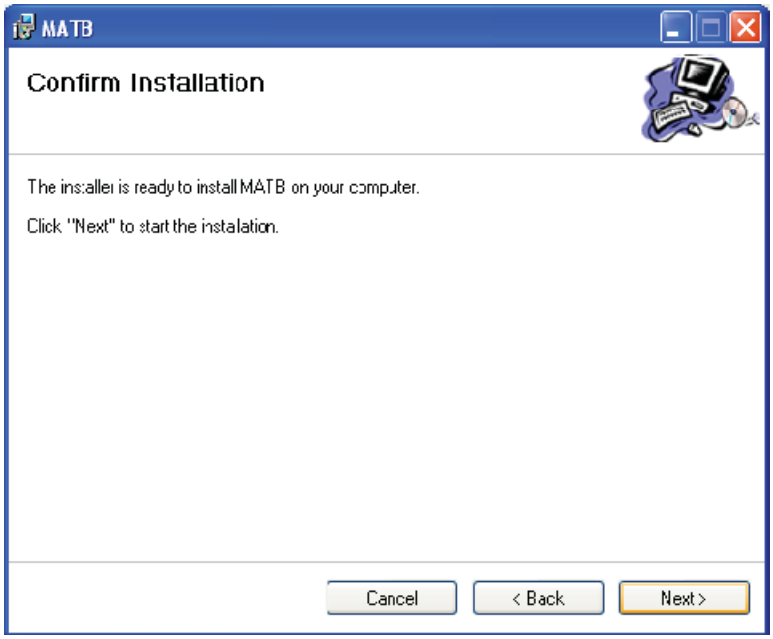


Figure 3-6. Select Next to confirm the installation

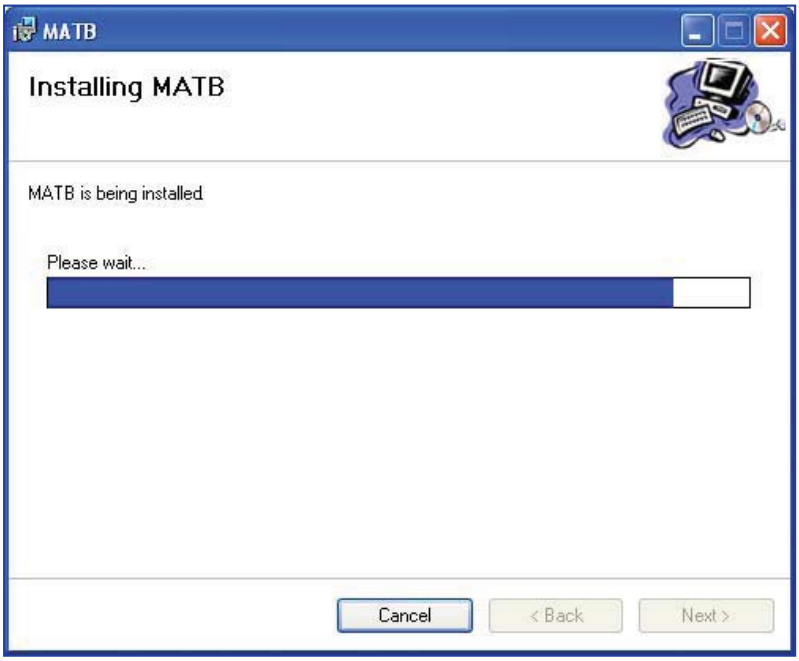


Figure 3-7. Progress Screen

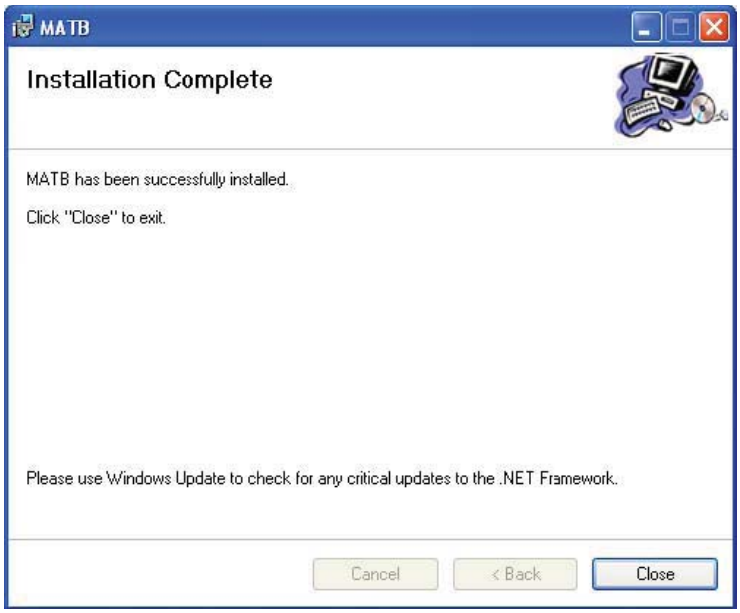


Figure 3-8. Click “Close” after the installation is done

Once the program is installed, the default location for the executable file (MATB-II.exe) is the \MATB folder on the main drive of the computer (Figure 3-9). In the following description, it is assumed that the main drive is the drive C:\.

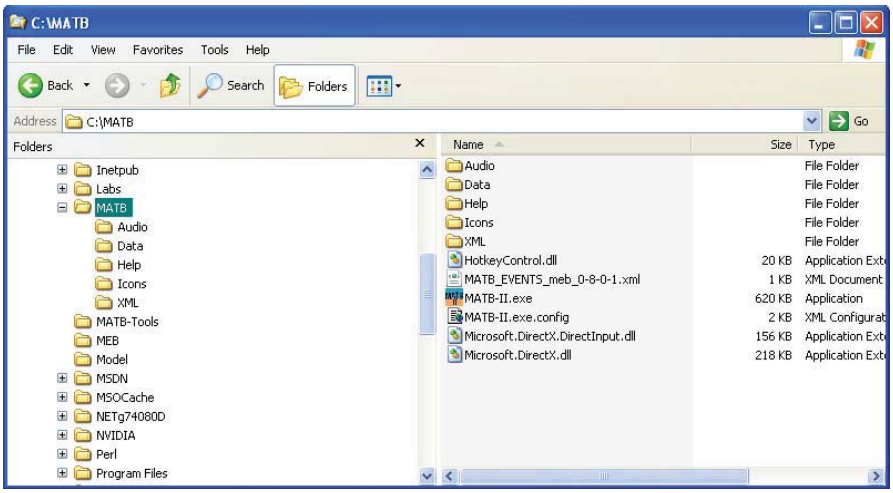


Figure 3-9. The “\MATB” Directory

The newly installed “\MATB” Directory contains five subdirectories, which are: Audio, Data, Help, Icons and XML. It also contains DLL components necessary to handle the joystick input. The “\MATB\Audio” directory contains 80 audio files

that can be used for the COMM task. Those 80 files are only part of a more comprehensive collection of audio files that is not copied to the “\MATB” directory during installation (Figure 3-10). The experimenter needs to locate the complete audio file library in the release package (or release CD) and copy them to the “\MATB\Audio” directory of the main computer drive.

The comprehensive audio file library located in the release package consists of 8 sets of 80 audio files for use with the communications task (Figure 3-10). It also contains 6 extra audio files used for testing. The sets of audio files that are contained in subfolders under the “\Audio” directory of the release package are named FEMALE_VOICE_SET_1, FEMALE_VOICE_SET_2, MALE_VOICE_SET_1, MALE_VOICE_SET_2, MIXED_SET_1, MIXED_SET_2, MIXED_SET_3 and MIXED_SET_4. The first four folders contain the sound recordings of one individual. The other four sets (MIXED_SET_1 to MIXED_SET_4) contain a mix of the four voices.

Figure 3-10. Folders not copied to the /MATB directory during installation.

The folders shown in Figure 3-10 are not copied to the \MATB directory automatically, but can be accessed by expanding the“\Audio” directory in the MATB-II release package.

3.2 Launching MATB-II

To prepare MATB-II for initial use, ensure that the MATB_CONFIG.XML and the MATB_EVENTS files are located in the \MATB\XML folder of the main drive of the computer. The version of the MATB_CONFIG.XML file that comes with the installation contains default settings that the experimenter can change to modify the appearance and operation of MATB-II.

The MATB_EVENTS.xml file that comes with the installation contains code that shows how to generate state changes in the task elements. The default MATB_EVENTS.xml file is created for illustrative purposes only, and is not intended to be used experimentally.

Copies of the MATB_CONFIG.xml and the MATB_EVENTS.xml are also provided in the \MATB\XML folder of the release package. If necessary, the files can be moved by accessing those folders and copying the files MATB_CONFIG.XML and MATB_EVENTS.xml to the \MATB\XML folder.

Open MATB-II as you would any other application on a Microsoft Windows computer. A convenient way of launching MATB-II is through setting the MATB-II shortcut on the Desktop to run MATB-II.exe or through the Start Menu.

3.3 MATB-II Startup Windows

If using an unedited version of the MATB_CONFIG.xml included with the distribution, at startup MATB-II will open the Select Events Files dialog (Figure 3-11).

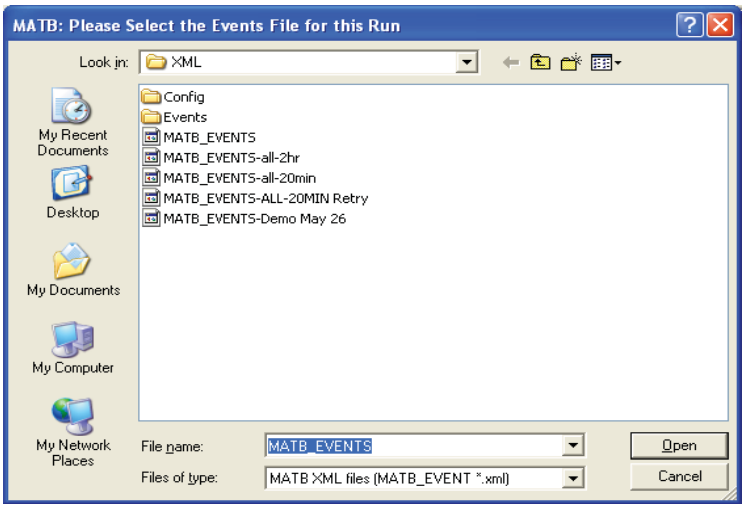


Figure 3-11. Selecting an Events File for execution

This dialog allows the selection of the events file to be used during the MATB session. By default, if an events file is not selected in the Select Events dialog, MATB-II loads the MATB_EVENTS.xml file. The experimenter can enable the Select Events File dialog by setting the SELECT_EVENTSFILE_MODE key to “true” in the MATB_CONFIG.xml file.

MATB-II also displays a dialog box that allows the experimenter to change the MATB-II run parameters, when the SET_RUN_PARAMS_MODE key is set to “true” in MATB_CONFIG.xml. This dialog box allows the user to modify configuration settings that are listed in the MATB_CONFIG.xml. The settings done through the SetRunParam dialogs are only valid for the run to which the changes are applied. Those changes will not be saved for subsequent runs. If the user wishes to make the changes permanent, he/she needs to edit and save them to MATB_CONFIG.xml. The settings that can be modified through the SetRunParam

include the flow rates for the tanks and pumps of RESMAN, the recording intervals for TRACK and RESMAN, the timeouts for the SYSMON, COMM and Workload Rating Scale events (Figure 3-12). Those settings are listed as the non-mode values of the MATB_CONFIG.xml.

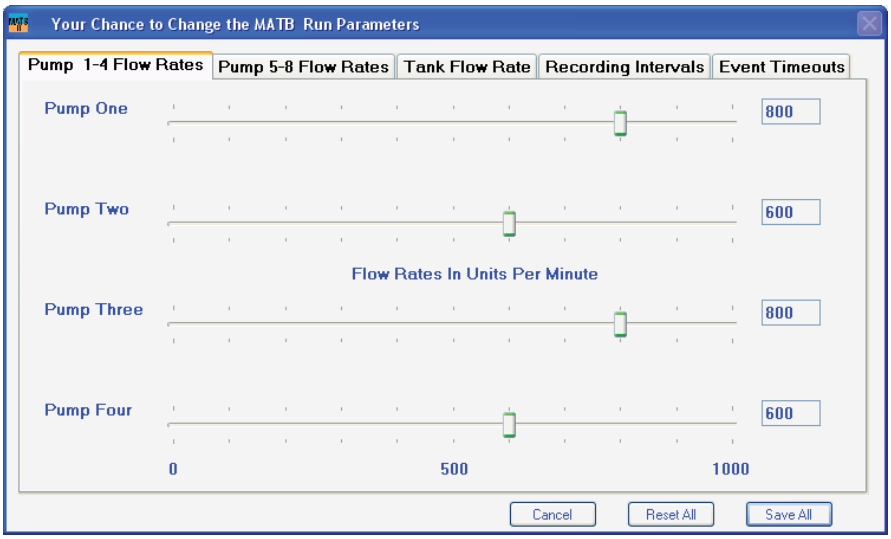


Figure 3-12. The Set Run Parameters Windows

See Section 4.1.2 to learn more about changing the operation modes of MATB-II.

3.4 Joystick Detection

During initialization, MATB-II checks for the presence of a joystick. If the joystick is not detected, the “Joystick Not Found” dialog is displayed (Figure 3-13).

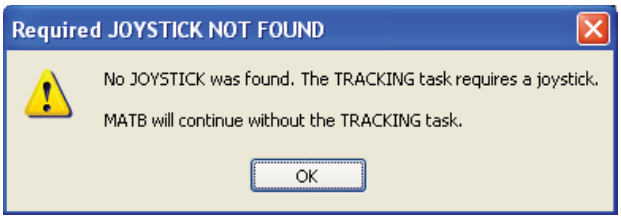


Figure 3-13. Joystick Not Found Error

In the absence of a joystick, MATB-II will proceed without the TRACK task once the “Joystick Not Found” dialog is closed (Figure 3-14). If the experimenter intends to run the application with the joystick, he/she must exit the application, connect the joystick and execute MATB-II again.

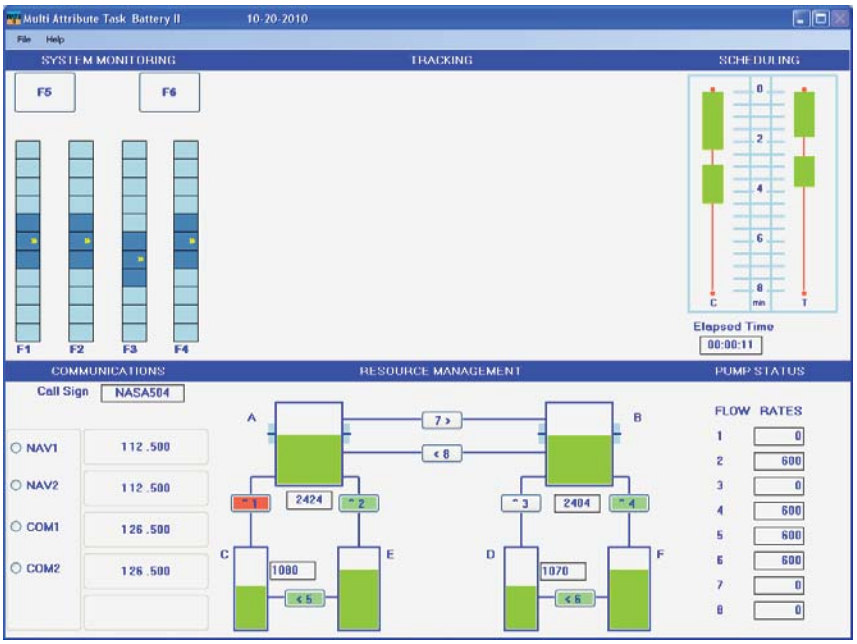


Figure 3-14. MATB-II Executing without the Tracking Task

3.5 Operation of MATB-II in Training and Testing Modes

When operating in Train mode (Figure 3-15), MATB-II displays a Train menu in the top toolbar that allows the user to play sample COMM task audio files and complete a workload rating session.

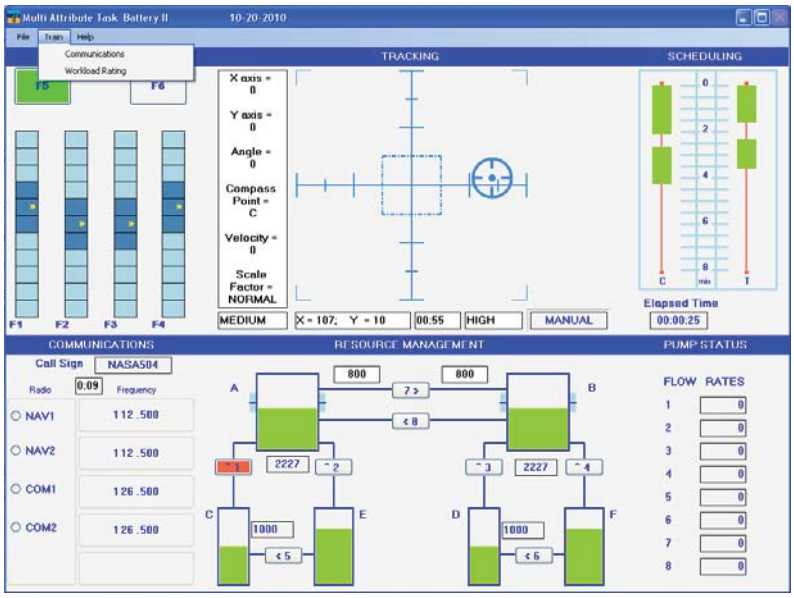


Figure 3-15. The MATB-II menu showing the Train option

When operating in Test mode (Figure 3-16) MATB-II adds a Test menu that allows the experimenter to play audio files and view information such as the scheduled events, the start and stop times of the COMM and TRACK sessions, the tank flow and consumption rates for RESMAN.

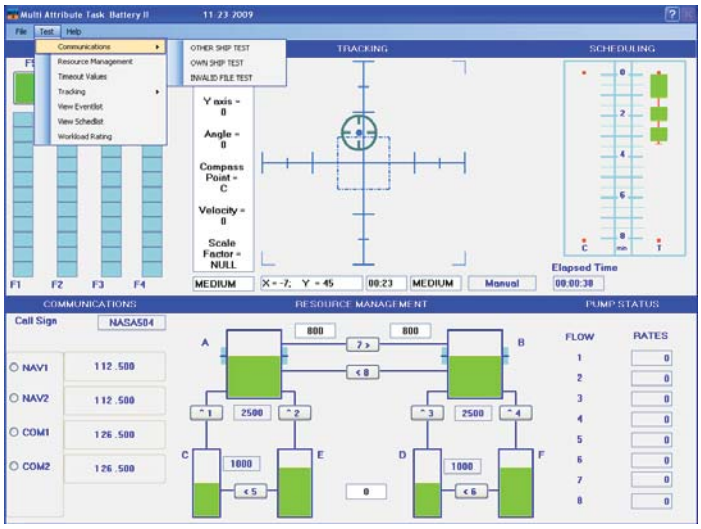


Figure 3-16. MATB-II GUI with the Test option enabled

In either the Test or Train modes, MATB-II displays white background text boxes that provide additional data, such as the target position in the TRACK task and event timers that appear within the tasks whenever an event is active. In the example below (Figure 3-17) the volumes of tanks E and F are constant. The labels to the left and right of pump 7 indicate the consumption rates of tanks A and B.

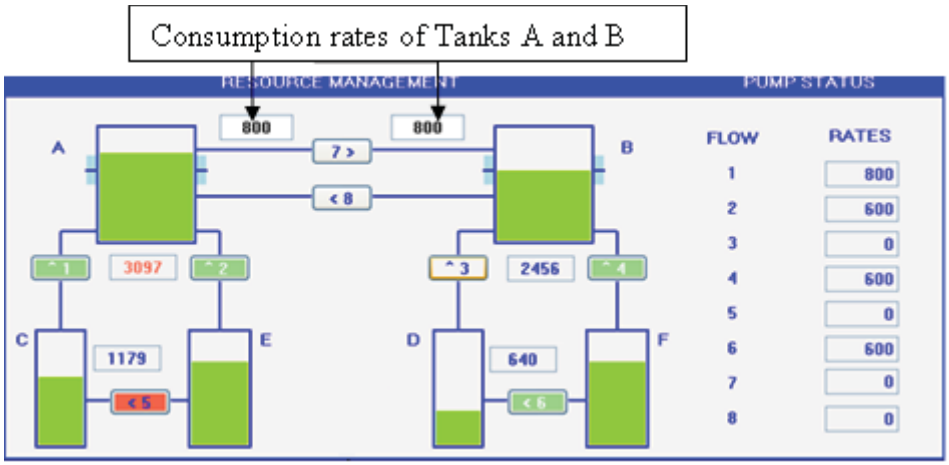


Figure 3-17. RESMAN shows update rates and consumption rates for the tanks

4 Control of Task Events

Two files control the behavior of MATB-II during a run. These are the MATB configuration file (MATB_CONFIG.xml) and the MATB events file (MATB_EVENTS .xml). If MATB-II does not find the MATB_CONFIG.xml file in the correct path on start up, it will display the dialog shown in Figure 4-1.

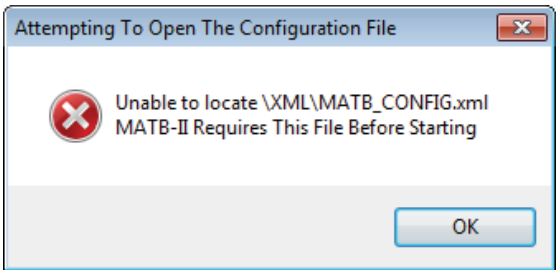


Figure 4-1. MATB_CONFIG.xml file not found dialog

4.1 The MATB_CONFIG.xml file

The configuration file allows the enabling of modes and features designed to facilitate experiment setup and subject training. The default settings are those deemed appropriate for data collection runs. In addition, the default timeouts of the tasks are also defined in the MATB_CONFIG.xml file. An annotated snippet of code from the MATB_CONFIG.XML file is included in Figure 4-2.

4.1.1 Elements of the MATB_CONFIG.xml file

The MATB_CONFIG.XML file determines the MATB-II operational modes and contains four different types of configuration data used by the application:
(1) A set of Boolean modes, which control the functionality of MATB-II. The experimenter can change the MATB-II modes based upon experimental needs.
(2) Resource management task (RESMAN) pumps volumetric values and main tank consumption rates, in units per minute.
(3) Timeout values, in seconds, for the communications (COMM) and system monitoring (SYSMON) tasks and the Workload Rating Scale (WRS). The timeout is

the amount of time (in seconds) that MATB-II will wait before returning the lights, scales, or the radio back to a nominal (normal) state. The lights and scales have independent timeout values. Table 4-1 describes the modes of the MATB-II.

(4) Recording intervals at which the data will be registered in the MATB-II's output files.

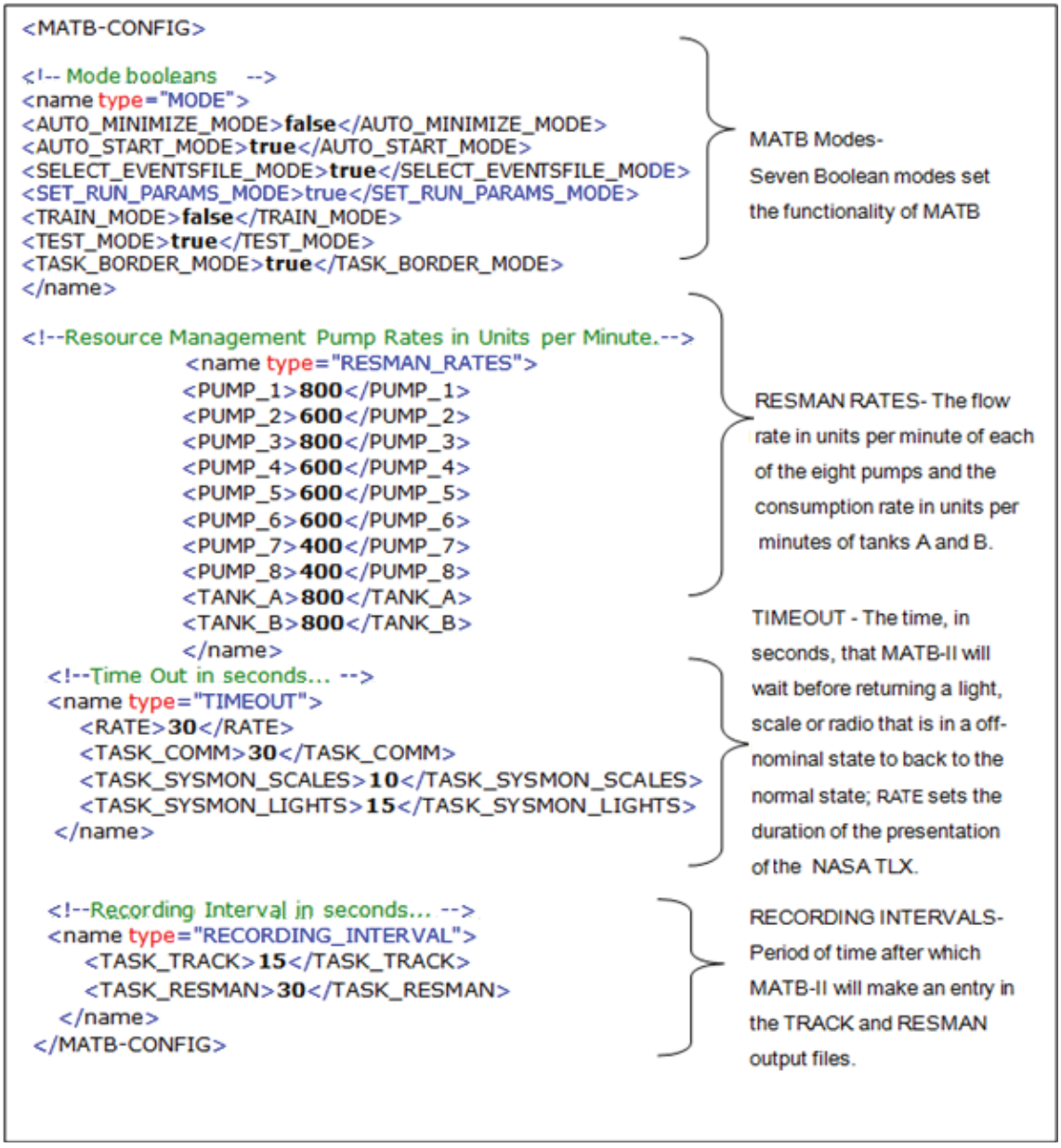


Figure 4-2. An annotated snippet of code from the MATB_CONFIG.xml file

4.1.2 MATB-II operational modes

Table 4-1 lists the MATB-II operational modes that can be specified through the MATB_CONFIG.xml file. By setting these modes to either true or false, an experimenter can enable or disable features on the MATB-II graphical user interface and modify the behavior of the application.

Table 4-1. MATB-II Modes

MATB_CONFIG file parameters	Acceptable Values
AUTO_MINIMIZE_MODE	TRUE: "Automatic Minimize" the MATB-II application window when another application takes the focus away from MATB-II. FALSE (Default): The MATB-II application will not minimize when it loses the focus to another process.
AUTO_START_MODE	TRUE (Default): "Automatic Start" of a run once initialization is completed FALSE: A dialog asks the user for acknowledgement to start the run.
SELECT_EVENTSFILE_MODE	TRUE (Default): At Startup, the application displays a file dialog that allows the selection of the Events file to be executed. FALSE: A dialog box asking the selection of the Events will not display, and MATB-II will execute the default MATB_EVENTS.xml during the session.
SET_RUN_PARAMS_MODE	TRUE: Provides a dialog to redefine the resource management task pump rate and tank consumption values. FALSE (Default): MATB-II will use the resource management task pump rates and tank consumption values set by default in the MATB_CONFIG.xml.
TRAIN_MODE	TRUE: Provides visual cues and a Train menu that the subject does not normally see during a data collection run. FALSE (Default): The Train menu items will not be enabled in the GUI.
TEST_MODE	TRUE: Provides visual cues and a Test menu that the subject does not normally see during a data collection run. FALSE (Default): The test menu items will not be enabled in the GUI.
TASK_BORDER_MODE	TRUE: Adds BLUE columns on either side of the TRACK task and between the COMM and RESMAN. FALSE (Default): Disables the drawing of borders between the task individual windows similar to those in MAT Battery.

4.1.3 Timeout Values

Figure 4-3 shows the section of the configuration file that defines the timeouts of the MATB-II tasks. In Figure 4-3, the timeout for the system monitoring scales is 10 seconds, and the timeout for the system monitoring lights is 15 seconds. The timeout values shown in the example for the Workload Rating Scale (WRS) and the communication task is 30 seconds each. This means that the subject has 30 seconds to respond before the task resets and MATB-II records an entry in the output file indicating that the task timed out. The timers start once an event is processed. The timeout value for the COMM task includes the time for presentation of the audio message.

```
<!-- Time Out in seconds...  -->
<name type="TIMEOUT">
 <RATE>30</RATE>
 <TASK_COMM>30</TASK_COMM>
 <TASK_SYSMON_SCALES>10</TASK_SYSMON_SCALES>
 <TASK_SYSMON_LIGHTS>15</TASK_SYSMON_LIGHTS>
 </name>
```

Figure 4-3. Timeout properties for the tasks specified in the MATB_CONFIG.xml file

The valid range for timeout values is from 10 seconds through 60 seconds. If the experimenter sets the timeout values outside that range, MATB-II overrides the values outside this range with the default values presented in Table 4-2.

Table 4-2. Default settings for timeouts in the MATB_CONFIG.xml

TASK	Timeouts, in seconds
RATE	30
COMM	30
SYSMON SCALES	10
SYSMON LIGHTS	15

4.1.4 Recording Intervals

Figure 4-4 shows the last portion of the MATB_CONFIG.xml which sets up recording intervals for the tracking and resource management tasks.

```
<!-- Recording Interval in seconds...  -->
<name type="RECORDING_INTERVAL">
 <TASK_TRACK>15</TASK_TRACK>
 <TASK_RESMAN>30</TASK_RESMAN>
 </name>
```

Figure 4-4. Recording intervals set in the MATB_CONFIG.xml file

In Figure 4-4, the recording interval for the TRACK task is 15 seconds, which means that MATB-II records the root mean square deviation of the target from the center point in pixel units (RMSD-C) every 15 seconds while the task is in manual mode. Each 30 seconds, MATB-II also registers the tank volumes and pump states data in the proper output file. Table 4-3 shows the default values for the recording intervals of the TRACK and the RESMAN tasks.

Table 4-3. Default recording intervals for TRACK and RESMAN

TASK	Recording Intervals, in seconds
TRACK	15
RESMAN	30

4.1.5 Creating and Saving a Customized Configuration File

The user can change any of the default settings of the configuration file by editing MATB_CONFIG.xml. Before the user makes changes to the MATB_CONFIG.xml file it is recommended to preserve a copy of the default configuration file. The original configuration file that comes with the MATB-II release can be saved as MATB_CONFIG-default.xml or similar name to allow returning to the default conditions in a later time, if desired.

MATB-II must find MATB_CONFIG.xml; any other filename will be ignored. If the experimenter has variations of the configuration file saved under different names, he/she will need to rename the desired file to MATB_CONFIG.xml so it can be used by MATB-II. The MATB_CONFIG.xml needs to be saved at the \MATB\XML folder.

That might be the case if the experimenter desires to have one configuration file for training and a different one for data collection. A naming convention like MATB_CONFIG-train.xml and MATB_CONFIG-run.xml can be used to be able to distinguish between the files, but the files need to be renamed to MATB_CONFIG.xml prior to use with MATB-II.

4.2 The MATB_EVENTS.xml File

Subjects respond to a series of events specified in an events file which uses Extensible Markup Language (XML) specification. The default file name for the events file is MATB_EVENTS.xml. The experimenter can create customized events files that might be selected for execution in MATB-II. Unlike the configuration file, which has to be named as the MATB_CONFIG.xml, customized events files can be saved under names other than the default name MATB_EVENTS.xml.

Through the use of the events file, the experimenter can set up control events for the tasks and change the state of MATB-II task components such as lights, scales, pumps and communications messages.

4.2.1 Editing the Events File Manually

The following explanation of the structure of the events file introduces the XML syntax required to control the tasks and construct the events to be executed by the MATB-II, for presentation to the subject. After a brief note regarding the XML syntax for the opening and closing markup elements, snippets of code will be used to illustrate the various components needed to create an events file.

There are several different types of events, each with different child elements. Control events use <control> element tags and can be used to manage the flow of the run and exclude tasks, if desired. Scheduling events use <sched> and can be used to define the parameters for manual and automatic task response sessions. Each task, other than the TRACK task, has its own element tag (e.g. <comm>, <resman>, and <sysmon>). Since the TRACK task is either in automatic or manual mode, its state is toggled by scheduling events. Each WRS event is launched with the <wrs> element tag.

4.2.2 MATB-II Events File Structure

The root element for all MATB events file is shown in Figure 4-5. Those tags comprise what is called the root element for the MATB events file. The rest of the MATB_EVENTS.xml file content is enclosed between the <MATB_EVENTS> and the </MATB_EVENTS> tags. It is important to follow the correct XML syntax when constructing events files; files with incorrect XML syntax will not be processed by MATB-II.

```
<MATB_EVENTS>
<!—Rest of the code  -->
</MATB_EVENTS>
```

Figure 4-5. MATB-II Events File Root Element

Controls precede the list of scheduling and task events. Control events are used to both “START” and “STOP” a run. Note the “startTime” attribute following the <event> elements in Figure 4-6. The “startTime” attribute represents the run elapsed time at which the event will be processed and is required after all “event” elements. The event “startTime” for a <control> element with the “END” value signifies the end of the run, after which no other events will be processed.

```
<MATB_EVENTS>
  <!-- Start MATB Timer  -->
  <event startTime="0:00:00">
     <control>START</control>
   </event>
</MATB_EVENTS>
```

```
<MATB_EVENTS>
  <!-- Stop MATB Timer and
    end experiment  -->
  <event startTime="0:20:00">
     <control>END</control>
   </event>
</MATB_EVENTS>
```

Figure 4-6. Control Events that “START” and “STOP” a run.

In Figure 4-6 the timer is started at time 0:00:00 and stopped at elapsed time 0:20:00. The XML syntax to designate a start time for an event is <event startTime="h:mm:ss">, where “startTime” is an attribute, “h” stands for the hour, “mm” for the minutes and “ss,” for the seconds. In the expression event startTime="0:20:00" the string “0:20:00” appears within quotes. It is necessary to use quotes when assigning a time value to the startTime attribute. The maximum length of a MATB-II run is two hours. If a run exceeds two hours, at initialization MATB-II will display the dialog shown in Figure 4-7.

Figure 4-7. Events File Maximum Time Error Window

4.2.3 SYSMON and RESMAN Activation

Unlike the COMM and TRACK tasks which may have multiple sessions where subject response may be required, the RESMAN and SYSMON tasks remain active once they accept events. Scheduling events are used to activate both tasks, either with a single event, or separately if only one of the tasks will respond to events during the run.

```
<!-- Start Resource Management and System
  monitoring tasks   -->
<event startTime="h:mm:ss">
  <sched>
     <task>RESSYS</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
```

Figure 4-8. Starting the resource management and system monitoring tasks

4.2.4 Setting up System Monitoring Events

The SYSMON task has six controls, two monitoring lights on the top and four scales below the lights. A description and examples of SYSMON task events follow.

After initiating the system monitoring (SYSMON) task, the experimenter can include code to cause state changes in each one of the lights and scales from the default state to an off-nominal state.

4.2.4.1 System Monitoring Light Events

The normal state of the left and right monitoring lights is ON (green) and OFF (gray or background) respectively. When a signal is presented to the subject the left monitoring light goes off and becomes gray (or background color), and the right light becomes red.

To change the state of the lights, one should generate associated XML entries. The possible types of monitoring light events are: (1) Green light (off), and (2) Red light (on). Figures 4-9 and 4-10 show the syntax for these events. The snippet of code in Figure 4-9 illustrates how to change the default state of the green light. The state change will cause the light to turn off.

```
<!-- SYSMON LIGHT  -->
<!-- System Monitoring - Turn Normally ON to OFF -->
<event startTime="h:mm:ss">
  <sysmon>
     <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
 </event>
```

Figure 4-9. SYSMON Event to turn the GREEN light OFF

Note that in the code of Figure 4-9, there is no XML attribute to indicate that the light will be turned off. The text value “GREEN” between the monitoringLightType tags creates an event to change the default state of the Green Light, thus turning it off. Similarly, to make the other SYSMON light change its default state and turn on, it is necessary to include a similar snippet of code, with the text value red “RED” between the monitoringLightType tags (Figure 4-10). Figure 4-10 illustrates how to change the default state of the light which is normally off. The state change will cause the light to turn on.

```
  <!-- SYSMON LIGHT  -->
<!-- System Monitoring - Turn Normally OFF to ON  -->
<event startTime=" h:mm:ss ">
  <sysmon>
     <monitoringLightType>RED</monitoringLightType>
   </sysmon>
 </event>
```

Figure 4-10. SYSMON Event to changing the state of the light normally OFF

4.2.4.2 System Monitoring Scale Events

There are four SYSMON scales. Events can be created that move the pointer for each scale up or down. These events are: (1) Scale one up, (2) Scale one down, (3) Scale two up, (4) Scale two down, (5) Scale three up, (6) Scale three down, (7) Scale four up and (8) Scale four down. Figure 4-11 shows the code to move Scale four's pointer up, and Figure 4-12 shows the syntax to move Scale one's pointer down.

```
<!-- SYSMON SCALES  -->
<!-- System Monitoring - Move SCALE FOUR UP  -->
<event startTime=" h:mm:ss ">
  <sysmon>
     <monitoringScaleNumber>FOUR</monitoringScaleNumber>
     <monitoringScaleDirection>UP</monitoringScaleDirection>
   </sysmon>
 </event
```

Figure 4-11. SYSMON Scale Four UP event

```
<!-- SYSMON SCALES  -->
<!-- System Monitoring - Move SCALE ONE DOWN  -->
<event startTime=" h:mm:ss ">
  <sysmon>
     <monitoringScaleNumber>ONE</monitoringScaleNumber>
     <monitoringScaleDirection>DOWN</monitoringScaleDirection>
   </sysmon>
 </event
```

Figure 4-12. SYSMON Scale One DOWN event

4.2.5 Tracking Task Events

In MATB-II the tracking task operates in either one of two types of modes: the manual (MANUAL) mode and the automatic (AUTO ON) mode. If a joystick is detected at the beginning of the MATB-II session, the tracking task will start in the automatic mode. The experimenter may schedule a MANUAL event session at any time and it is common to do so immediately after start up.

Figure 4-13 shows the syntax to schedule the start of a manual session of the tracking task at time “0:00:05”.

```
    <!-- #  TRACK MANUAL  -->
<!-- Sched task: TRACK START  -->
<event startTime="0:00:05">
  <sched>
     <task>TRACK</task>
     <action>MANUAL</action>
     <update>MEDIUM</update>
     <response>MEDIUM</response>
   </sched>
 </event>
```

Figure 4-13. Start a manual event in a tracking session

The valid entries for the <action> element are AUTO and MANUAL. The <update> element refers to the amount of random target movement per update cycle, and the <response> element refers to the amount of influence the joystick has on target movement per update cycle. Valid entries for the <update> and <response> elements that control the joystick are LOW, MEDIUM and HIGH.

To switch the tracking task mode from manual to automatic it is necessary to initiate an automatic session of the tracking task. The task is returned to the normal state with an AUTO <action> element value. The <update> and <response> elements have no effect in AUTO mode and should have NULL values (Figure 4-14).

```
<!--  TRACK AUTO  -->
<!--  Sched task: TRACK STOP  -->
<event startTime="h:mm:ss">
 <sched>
      <task>TRACK</task>
      <action>AUTO</action>
      <update>NULL</update>
      <response>NULL</response>
 </sched>
</event>
```

Figure 4-14. Changing from Manual to Automatic Mode

4.2.6 Scheduling of a Communications Session

To set up the COMM task, the experimenter needs to create events that establish a session before scheduling events inside that session. A session will be active from the time it is scheduled to start until the time it is scheduled to stop. The code in the left column of Figure 4-15 starts a session; while the code in the right column ends it.

```
<!--Start Communications task  -->
<event startTime="h:mm:ss">
  <sched>
     <task>COMM</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
 </event>
```

```
<!-- Sched task: COMM STOP  -->
<event startTime=="h:mm:ss">
  <sched>
     <task>COMM</task>
     <action>STOP</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
 </event>
```

Figure 4-15. Scheduling the start and end of a COMM session

Similarly to the RESSYS task illustrated by Figure 4-8, note that the <update> and <response> elements will be set to NULL when setting up the COMM task.

4.2.7 Communications Events

As noted in the previous section, the experimenter must schedule a COMM task session before adding COMM events to the MATB_EVENTS.xml file (Figure 4-15). Through the use of the XML tags, the experimenter indicates the ship, radio and frequency that MATB-II will play during execution. Figure 4-16 shows an example in which the instruction is intended for another aircrew. In Figure 4-16, the values for the <ship>, <radio> and <freq> elements have been set to OTHER, COM2, 118.275. Given these settings, MATB-II will play the WaveFormFile with the name of "OTHER_COM2_118-275.wav". This file is located in the '\MATB\Audio directory' of the main computer drive at approximately 5 minutes and 15 seconds into the run, although approximately an additional 10 seconds might elapse before the audio file message is completed. The duration of the COMM instructions should be taken into account when adding events immediately after a COMM event.

```
<!-- COMM OTHER  -->
<!-- Other ship radio change  -->
<event startTime=" 0:05:15 ">
  <comm>
     <ship>OTHER</ship>
     <radio>COM2</radio>
     <freq>118.275</freq>
   </comm>
 </event>
```

Figure 4-16. Other Ship COMM event

When issuing a call to NASA504, the <ship> element is set to OWN (Figure 4-17).

```
<!--  Own ship radio change  -->
<event startTime="0:06:31">
 <comm activity="START">
     <ship>OWN</ship>
     <radio>COM1</radio>
     <freq>127.550</freq>
  </comm>
 </event>
```

Figure 4-17. Own Ship COMM event

Once MATB-II processes the event shown in Figure 4-17, the program will play the Waveform file OWN_COM1_127-550.wav at a run elapsed time of 6 minutes and 31 seconds.

Possible values for the <radio> element are COM1, COM2, NAV1, and NAV2. Table 4-4 lists the range of selectable values for the <freq> element of the communications task radios.

Table 4-4. Frequencies for each radio of the COMM task

Radio	Frequency Range
NAV 1	108.000 to 117.950 with increments of 0.050
NAV 2	108.000 to 117.950 with increments of 0.050
COM 1	118.00 to 135.975 With increments of 0.025
COM 2	118.00 to 135.975 With increments of 0.025

If the experimenter would like to create customized audio files, he/she can refer to Appendix Q, where guidance on generating audio files may be found. The appendices also contain supplementary information about the frequencies and the Airline Call signs used in aviation. They also provides guides and a protocol to create additional audio scripts, the audio file naming convention and the format for playing these audio files in MATB-II.

4.2.8 Resource Management Events

Similar to the SYSMON task, the RESMAN task can be initiated simultaneously with SYSMON through the use of the <RESSYS> entry previously explained in the Section 4.2.3. The event to initiate RESMAN only is shown in Figure 4-18.

```
<!-- Start Resource Management and System
  monitoring tasks   -->
<event startTime="0:00:00">
  <sched>
     <task>RESMAN</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
```

Figure 4-18. Event to initiate the RESMAN task

During the execution of the RESMAN task, if the events file calls for it, the pumps might fail, and the subject might need to redirect the fuel to keep the fuel level in tanks A and B near the target of 2500 units. RESMAN events either fail (Figure 4-19) or return pumps to a deactivated state (Figure 4-20).

```
<!-- RESMAN PUMP FAIL  -->
<!-- RESMAN task: fail pump 1   -->
<event startTime="0:07:22">
 <resman>
    <fail>P1</fail>
  </resman>
 </event>
```

Figure 4-19. RESMAN Pump ONE Failed event

In Figure 4-19, the experimenter enters the pump number to be failed between the <fail> and </fail> elements of the code shown above. Valid values are P1, P2, P3, P4, P5, P6, P7 and P8. Pumps are returned to the normal state with the

<fix> element and the pump of interest (Figure 4-20). In this example, pump 1 failed at elapsed time 0:07:22 (Figure 4-19) and is fixed at time 0:07:57 (Figure 4-20).

```
<!-- RESMAN PUMP FIX  -->
<!-- RESMAN task: fix pump 1   -->
<event startTime="0:07:57">
  <resman>
     <fix>P1</fix>
   </resman>
 </event>
```

Figure 4-20. RESMAN Pump ONE Fixed event

4.2.9 Workload Rating Scale (WRS) Events

The Workload Rating Scale (WRS) may be displayed at any time during the execution of MATB-II. Figure 4-21 shows the code display the WRS for subject input at time 1:10:30.

```
<!-- Workload Rating -->
<event startTime="1:10:30">
 <wrs>START</wrs>
 </event>
```

Figure 4-21. A WRS event

As stated in Section 2.6, the MATB-II elapsed timer pauses while the WRS is active.

4.2.10 Naming and Saving the MATB_EVENTS.xml file

The naming convention of the events file is MATB_EVENTS-xxxx.xml file, where “xxxx” is user defined. The name of the default events file is MATB_EVENTS.xml. The experimenter may either use the default name or create a customized file. The suggested convention for naming a customized events file is using the prefix ‘MATB_EVENTS’, adding a dash, (*i.e.* MATB_EVENTS-) and

append an identifying string; for instance, MATB_EVENTS-20min.xml is a file that lasts 20 minutes. Once created, the MATB_EVENTS.xml file will need to be stored in the " \MATB\xml" directory of the main computer drive. To be able to select another events file at the beginning of the MATB session, set the value for the <SELECT_EVENTSFILE_MODE> parameter in MATB_CONFIG to "true".

The MATB-II User Guide for Creating Events files (Appendix L) provides additional information with examples on working with the MATB-II events. Additionally there are worksheets and XML templates that serve as aids in the creation of the events files for MATB-II. The Appendix also provides a complete example of a MATB_EVENTS.xml file.

5 Understanding Output Data Files

5.1 Naming conventions

MATB-II records both the processing of events and the subject's responses in a master file. The notation used for the master file is the MATB_yyyy_mmddhhmm.txt, where the 'yyyy_mmddhhmm' denotes the current date and time information of the run. A key feature of MATB-II is the unique identification of any run.

Besides MATB_ yyyy_mmddhhmm.txt, other files register the events and subject actions per each corresponding MATB-II task. MATB-II produces both a text version and comma separated version of the SYSMON, TRACK, COMM, RESMAN tasks and the WRS. These files are:

(a) SYSM_ yyyy_mmddhhmm.txt and the SYSM_ yyyy_mmddhhmm.csv, for SYSMON;

(b) TRCK_ yyyy_mmddhhmm.txt and the TRCK_ yyyy_mmddhhmm.csv, for TRACK;

(c) RMAN_ yyyy_mmddhhmm.txt and the RMAN_ yyyy_mmddhhmm.csv, for RESMAN;

(d) COMM_ yyyy_mmddhhmm.txt and the COMM_ yyyy_mmddhhmm.csv, for COMM, and WRS_ yyyy_mmddhhmm.txt, and

(e) WRS_ yyyy_mmddhhmm.txt and the WRS_ yyyy_mmddhhmm.csv for the Workload Rating Scale (WRS).

For instance, a file named "COMM_2011_01061756.txt" would be a COMM output data file created in the year 2011, on the first month (01), the 6th day (06), at 17:56, which correspond to 5:56 p.m. of January 6th, 2011.

5.2 Commonalities among the data file headers

All the output data files generated by MATB-II have a basic information header that includes the date and the time the output file was created, the name of the output file and the events file used by MATB-II when the output file was created (Figure 5-1). For example, the opening lines of the MATB_2011_02112041.txt illustrated below (Figure 5-1) let an experimenter know that a MATB-II session was executed on February 11, 2011 at 8:41 p.m., using the events file named MATB_EVENTS-5min-Rating.xml.

```
# 02-11-2011     20:42:14     MATB_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
```

Figure 5-1. Output file header for a MATB_2011_02112041.txt output file

The six data files generated by MATB-II list the sequence and the initiation time of the events, the state changes of the task components and the response time of the subjects. The data files record performance data, such as response times and an indication whether the action taken by the subject was appropriate.

5.3 The MATB output file

For each experimental run, a MATB_ yyyy_mmddhhmm.txt data file is generated. This file records event processing and subject response, or lack of response. Similarly, when the user performs an action, a user event is registered with the name of the task to which the event belongs. The name of the events file used during the run is recorded below the timestamp information.

Figure 5-2 shows an excerpt of a MATB_yyyy_mmddhhmm.txt file. A complete MATB-II output file for a 5 minute run appears in Appendix O.

```
# 02-11-2011     20:42:14     MATB_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# TIME          EVENT    ACTION                                    REMARKS
#-------------------------------------------------------------------------------------------------------
00:00:00.0          Device Initialization:                        - Joystick Connected -
00:00:17.0       1  Event Processed:  Control
00:00:17.5       2  Event Processed:  Scheduling                  - RESMAN and SYSMON Active
00:00:18.0       3  Event Processed:  Scheduling                  - TRACK in Manual Mode
00:00:18.5       4  Event Processed:  Resource Management         - Pump ONE Failed
00:00:19.0       5  Event Processed:  System Monitoring           - GREEN Light
00:00:19.3          Subject Response: Resource Management         - Pump TWO
00:00:20.1          Subject Response: System Monitoring           - GREEN Light
00:00:21.2          Subject Response: Resource Management         - Pump FOUR
00:00:22.2          Subject Response: Resource Management         - Pump THREE
00:00:22.6          Subject Response: Resource Management         - Pump SIX
00:00:23.5          Subject Response: Resource Management         - Pump FIVE
00:00:30.0          Recording Interval Triggered: Resource Management
00:00:33.1          Recording Interval Triggered: Tracking
00:00:34.0       6  Event Processed:  Scheduling                  - COMM Session Started
00:00:35.0       7  Event Processed:  Resource Management         - Pump ONE Fixed
00:00:40.0       8  Event Processed:  Communications              - COM ONE OWN Ship
00:00:40.0          Event Terminated: Communications
00:00:45.0       9  Event Processed:  Resource Management         - Pump FIVE Failed
00:00:45.6          Subject Response: Resource Management         - Pump ONE
00:00:48.1          Recording Interval Triggered: Tracking
00:00:48.4          Subject Response: Communications              - COM1 Response Inappropriate
00:00:49.2          Subject Response: Communications              - FREQ Integer
00:00:49.5          Subject Response: Communications              - FREQ Integer
00:00:50.8          Subject Response: Communications              - FREQ Decimal
00:00:52.7          Subject Response: Communications              - FREQ Decimal
00:00:53.0      10  Event Processed:  System Monitoring           - RED Light
00:00:53.4          Subject Response: Communications              - FREQ Decimal
00:00:55.5          Subject Response: Communications              - Enter Button Selected
00:00:56.9          Subject Response: System Monitoring           - RED Light
00:01:00.0          Recording Interval Triggered: Resource Management
00:01:03.1          Recording Interval Triggered: Tracking
00:01:13.0      11  Event Processed:  System Monitoring           - Scale TWO
00:01:15.0      12  Event Processed:  Resource Management         - Pump FIVE Fixed
00:01:19.4          Subject Response: System Monitoring           - Scale TWO
00:01:19.9          Subject Response: System Monitoring           - Scale TWO Response Inappropriate
00:01:20.0      13  Event Processed:  Communications              - COM TWO OTHER Ship
00:01:20.3          Subject Response: System Monitoring           - Scale TWO Response Inappropriate
00:01:24.8          Subject Response: Resource Management         - Pump FIVE
00:01:28.8          Subject Response: Resource Management         - Pump FOUR
00:01:29.7          Subject Response: Resource Management         - Pump THREE
00:01:30.0          Recording Interval Triggered: Resource Management
00:01:31.3          Subject Response: Resource Management         - Pump FOUR
00:01:39.0          Subject Response: Resource Management         - Pump ONE
00:01:41.5          Subject Response: Resource Management         - Pump EIGHT
00:01:48.5          Subject Response: Resource Management         - Pump THREE
00:01:50.0          Event Terminated: Communications
00:02:00.0      14  Event Processed:  Scheduling                  - TRACK in Auto Mode
00:02:00.0          Recording Interval Triggered: Resource Management
00:02:05.0      15  Event Processed:  Communications              - NAV TWO OTHER Ship
00:02:13.0      16  Event Processed:  System Monitoring           - GREEN Light
00:02:15.8          Subject Response: System Monitoring           - GREEN Light
00:02:20.0      17  Event Processed:  Resource Management         - Pump EIGHT Failed
```

Figure 5-2. Extract of MATB_2011_02112041.txt showing the events executed by MATB-II

MATB_2011_02112041.txt records the elapsed time the event was processed under the “TIME” column. Each event has an identification number that is registered in the EVENT column (second column from left to right in Figure 5-2).

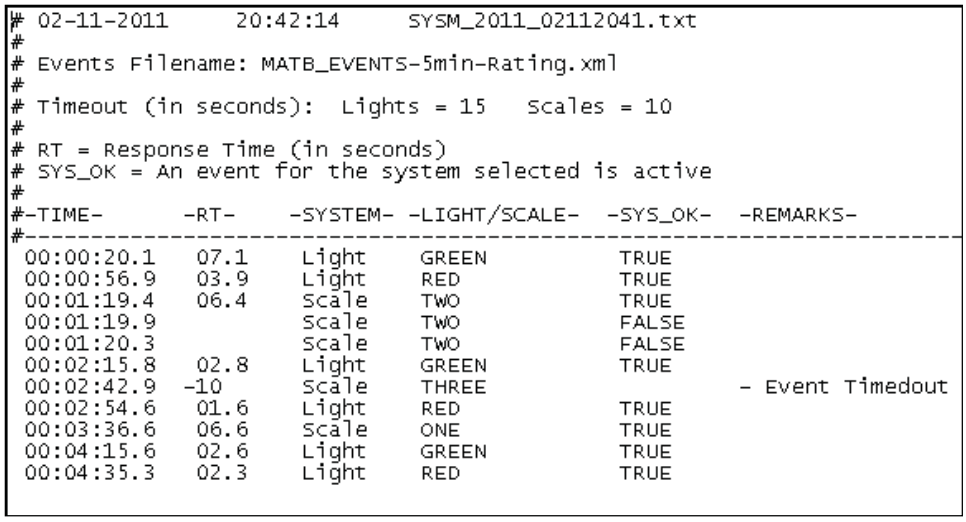
Each time the subject responds to a task event the response is recorded. In the text file shown in Figure 5-2, a SYSMON GREEN LIGHT ON event was processed at 19.0 seconds. About that same time, the subject was turning pump 2 on before clicking on the GREEN LIGHT at 20.1 seconds.

In the MATB_2011_02112041.txt, the subject action on Scale TWO at 1 minute and 20 second was recorded as a “Scale TWO Response Inappropriate”. A common practice is to mistakenly click on a SYSMON scale more than once to restore its normal operation. MATB-II records these extraneous inputs as “Inappropriate responses”. Additionally, corrective actions the subject makes on a task component that was not in an abnormal state are recorded as “Inappropriate responses”.

Subject responses to event state changes are also recorded in the corresponding task output file. Cross referencing the elapsed time of entries may provide different views of the same scripted event and subject responses to scripted events.

5.4 The System Monitoring output file

The SYSM_yyyy_mmddhhmm.txt file shows the timeouts for the scale and lights, the time at which the SYSMON events occurred, the reaction time of the subject, the type of SYSMON event (whether a light or a scale event), the task component affected (whether it was the green light or the red light, or a specific scale), and the outcome of the action taken by the subject. If the subject performed correctly, a “true” value is registered under the SYS_OK column. Figure 5-3 shows a SYSMON output data file which is named SYSM_2011_02112041.txt.



```
# 02-11-2011     20:42:14     SYSM_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# Timeout (in seconds):  Lights = 15   Scales = 10
#
# RT = Response Time (in seconds)
# SYS_OK = An event for the system selected is active
#
#-TIME-      -RT-    -SYSTEM- -LIGHT/SCALE-  -SYS_OK-  -REMARKS-
#-------------------------------------------------------------------------
 00:00:20.1   07.1    Light    GREEN          TRUE
 00:00:56.9   03.9    Light    RED            TRUE
 00:01:19.4   06.4    Scale    TWO            TRUE
 00:01:19.9           Scale    TWO            FALSE
 00:01:20.3           Scale    TWO            FALSE
 00:02:15.8   02.8    Light    GREEN          TRUE
 00:02:42.9  -10      Scale    THREE                  - Event Timedout
 00:02:54.6   01.6    Light    RED            TRUE
 00:03:36.6   06.6    Scale    ONE            TRUE
 00:04:15.6   02.6    Light    GREEN          TRUE
 00:04:35.3   02.3    Light    RED            TRUE
```

Figure 5-3. The SYSM_2011_02112041.txt output file registers events and subject responses for the system monitoring task

The file in Figure 5-3 records that the timeout for the light event is 15 seconds and the timeout for the scale events is 10 seconds. According to the information in this data file, the subject responded correctly at a time of 1:19.4, and then clicked the same scale twice within the next second. The subject clicked the same scale on Scale 2 three times between 1 minute and 19 seconds and 1 minute and 20 seconds into the run. The first time the subject clicks Scale 2, the action is classified as correct, as shown by the “true” value that appears under SYS_OK column. The second and third time the subject responds (an apparent overshoot action), these actions are registered as incorrect, as indicated by the FALSE entry under the SYS_OK column.

The output file also registers that the scale timed out approximately 2 minutes 43 seconds into the run. Since the subject didn’t respond within the 10 second interval, the “-10” value is stored in the Response Time column, and labeled “Event Timedout”.

For a detailed explanation of the Output File Entries for SYSMON Events, please refer to the Appendix, Section F.13.

5.5 The Tracking output file

Tracking state data for the joystick is recorded at the time interval specified in the MATB_CONFIG file (Section 4.1.1, Fig 4-2). For the tracking task, the root mean square deviation from the center point in pixel units (RMSD-C) is calculated and recorded along with the number of samples during the interval. MATB-II generates two versions of the TRCK output file, a text version (Figure 5-4), and a comma separated value version.

```
#
#  The Absolute Value of the Vertical Pixel and Horizontal Pixel
#  offsets from the Center Point are added and the sum squared
#
# SS = Sum Of Squares; NUM = Number of Samples
# RMSD-C = Square Root (SS / NUM)
#
# TU = Target Update Rate; JR = Joystick Response Rate
#
# Recording Interval is 15 seconds
#                                THIS INTERVAL                    SESSION AGGREGATE                RUN AGGREGATE
#-ELASPED TIME  -SESSION TIME  -NUM   -SUM OF SQUARES  -RMSD-C      -NUM   -SUM OF SQUARES  -RMSD-C  -NUM   -SUM OF SQUARES -RMSD-C  -Remarks
#-------------------------------------------------------------------------------------------------------------------------------------------
00:00:33.1     00:15          276   21,994,041       282.292       276    21,994,041       282.292  276    21,994,041   282.292  Begin: TU: HIGH, JR: MEDIUM
00:00:48.1     00:30          276   24,840,000       300.000       552    46,834,041       291.280  552    46,834,041   291.280
00:01:03.1     00:45          276      155,876         23.765       276       155,876         23.765  898    53,289,917   243.604  Begin: TU: MEDIUM, JR: HIGH
00:03:00.1     00:15          276      119,436         20.802       552       275,312         22.333  1174   53,409,353   213.292
```

Figure 5-4. The file TRCK_2011_02111855.txt registers the joystick offset from the central position

Observe that the values under the Session Time Column restart. Sampling data is stored in three different sets of registers; the first is reset at the end of each interval, the second at the end of each session and the third is updated without resetting for the entire run. This allows different views of the subject's response. The Appendix provides more detail on output file entries for the TRACK events.

5.6 The Communications output file

The COMM_yyyy_mmddhhmm.txt output file records data relevant to the subject's response to this task. The columns labeled as SHIP, RADIO_T, and FREQ_T (Figure 5-5) display the message ship, radio and frequency the subject was instructed to select (in the ATC message). FREQ_T stands for "target frequency". The columns RADIO_S and FREQ_S present the radio and frequency selected by the subject. If the subject selects the correct radio and the correct frequency, the R_OK (Radio Okay) and F_OK (Frequency Okay) columns will be

set to “True”. If the subject does not respond to an instruction intended for another aircraft, a NULL value is registered under the Radio and Frequency column, and “True” values are registered under the R_OK and the F_OK. However, if the subject does not respond to an instruction intended for NASA504 (an undesirable omission), NULL values are registered under the Radio and Frequency columns, and “False” values are registered under the R_OK and the F_OK.

```
# 02-11-2011     20:42:14     COMM_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# Timeout (in seconds) = 30
#
# _T = Target, _S = Selected
# R_ = Radio,  F_ = Frequency
#
#-TIME-     -RT-  -SHIP-  -RADIO_T-  -FREQ_T-  -RADIO_S-  -FREQ_S_  -R_OK-   -F_OK-   -REMARKS
#-------------------------------------------------------------------------------------------------------------
 00:00:40.0   -30      OWN     COM1       124.575   NULL       NULL      False    False  -Event Timedout
 00:01:50.0   +30      OTHER   COM2       130.725   NULL       NULL      True     True
 00:02:28.3  8.5       OTHER   NAV2       115.050   NAV2       115.050   False    False
 00:03:23.7 12.0       OWN     COM1       126.450   COM1       126.450   True     True
 00:04:15.0  +30       OTHER   COM2       120.775   NULL       NULL      True     True  -Appropriate Subject Response
```

Figure 5-5. The COMM_2011_02112041.txt file recording of communications events and responses

According to the COMM_2011_02112041.txt output file (Figure 5-5), at 40 seconds into the run the subject didn’t respond to an ATC call issued to Own Ship. The COMM event timed out at 30 seconds and the subject didn’t respond to an event that he/she was expected to respond. For that reason a value of -30 is registered in the RT (response time) column; since no radio was selected at that time, a value of “NULL” is listed both under the –RADIO_S and –FREQ_S columns. In contrast, when the subject lets a COMM event time out at 4 minutes 15 seconds, the action is recorded as ‘Appropriate’ in the Remarks section and a value of +30 is recorded in the RT column. A positive sign is used next to the timeout value, when the subject’s lack of response is appropriate. At 2 minutes and 28 seconds, the subject mistakenly responded to a call that was issued to OTHER Ship. Even though the radio and frequency selected corresponded to what was said in the instructions (NAV2, 115.050), MATB-II records the action as incorrect, since the subject responded to an instruction issued to OTHER SHIP. Therefore, “False” values are registered under the R_OK and F_OK columns.

5.7 The Resource Management output file

Tank volumes, pump failures and pump actions will cause the application to record an entry on the RMAN output files. The tank volumes are also recorded at the end of a configurable time interval. When the entry is a result of a pump action (the subject takes action on a particular pump) an “N” is recorded in the “TANK UPDATE” column. A “Y” is recorded in the “TANK UPDATE” when the tank update event is triggered by the recording interval timer. Entries made as result of time interval recordings have blank spaces under the columns that record pump information. Those columns are labeled as –PUMP # and –PUMP ACTION in the RMAN_2011_02112041.txt file in Figure 5-6.

```
# 02-11-2011     20:42:14     RMAN_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# Pump Flow Rates in Units Per Minute
# Pump 1 = 800   Pump 2 = 600   Pump 3 = 800   Pump 4 = 600
# Pump 5 = 600   Pump 6 = 600   Pump 7 = 400   Pump 8 = 400
#
# Tank Consumption Rates in Units Per Minute
# Tank A = 800   Tank B = 800
#
# Recording Interval is 30 seconds
#
# N = Recording trigged by a pump action
# Y = Recording trigged by a timer, and not a pump action
#
# DIFF A = Amount above or below the tank A target volumn of 2500 units
# DIFF B = Amount above or below the tank B target volumn of 2500 units
#
#-ELAPSED TIME   -PUMP # -PUMP ACTION -TANK UPDATE  -TANK A  -TANK B  -TANK C  -TANK D  -DIFF A  -DIFF B
#-------------------------------------------------------------------------------------------------------
 00:00:18.5       1       Fail          N             2487     2487     1000     1000      -13      -13
 00:00:19.3       2       On            N             2474     2474     1000     1000      -26      -26
 00:00:21.2       4       On            N             2468     2448     1000     1000      -32      -52
 00:00:22.2       3       On            N             2465     2445     1000     1000      -35      -55
 00:00:22.6       6       On            N             2465     2445     1000     1000      -35      -55
 00:00:23.5       5       On            N             2462     2455     1000      997      -38      -45
 00:00:30.0                             Y             2444     2515     1060      979      -56       15
 00:00:35.0       1       Fix           N             2429     2565     1110      964      -71       65
 00:00:45.0       5       Fail          N             2399     2665     1210      934     -101      165
 00:00:45.6       1       On            N             2396     2675     1210      931     -104      175
 00:01:00.0                             Y             2536     2815     1028      889       36      315
 00:01:15.0       5       Fix           N             2686     2965      833      844      186      465
 00:01:24.8       5       On            N             2786     3065      703      814      286      565
 00:01:28.8       4       Off           N             2826     3105      691      802      326      605
 00:01:29.7       3       Off           N             2836     3105      688      799      336      605
 00:01:30.0                             Y             2836     3105      688      799      336      605
 00:01:31.3       4       On            N             2856     3079      682      819      356      579
 00:01:39.0       1       Off           N             2936     3055      658      899      436      555
 00:01:41.5       8       On            N             2930     3049      678      919      430      549
 00:01:48.5       3       On            N             2958     2979      748      989      458      479
 00:02:00.0                             Y             3002     3012      858      956      502      512
 00:02:20.0       8       Fail          N             3082     3072     1058      896      582      572
 00:02:30.0                             Y             3052     3172     1158      866      552      672
 00:02:41.8       3       Off           N             3016     3292     1278      830      516      792
 00:02:44.7       2       Off           N             3007     3283     1308      860      507      783
 00:02:50.0       8       Fix           N             2942     3268     1358      910      442      768
 00:03:00.0                             Y             2812     3238     1458     1010      312      738
```

Figure 5-6. The RMAN_2011_02112041.txt file record of tank updates and subject pump actions

The file shown in Figure 5-6 was produced as MATB-II executed with a recording interval of 30 seconds.

5.8 The Workload Rating Scale output file

The values for the Workload Rating Scale (WRS), based on the NASA-TLX implemented in the MATB-II, range from zero (0) (minimum) to one hundred (100). The scale anchors visible to the subject are “Low” to “High” or “Good” to “Poor”. The subject moves the sliders of each of the subscales to indicate the extent to which they were affected by the task workload. The subject clicks “Save All” to complete the Workload Rating Scale, and to save ratings in the WRS_ yyyy_mmddhhmm.txt file. The WRS_ yyyy_mmddhhmm.txt file (Figure 5-7) records the elapsed time at which the event was processed, the time it took the subject to complete the rating, and the rating score for each of the subscales. The ‘Low’ to ‘High’ and ‘Good’ to ‘Poor’ values are converted to a numeric score from between “0” and “100” and the mean value is also recorded.

```
# 02-11-2011     20:42:14     WRS_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# Timeout (in seconds) = 30
#
#-TIME-NOW -TIME-   -MENL- -PHYS- -TEMP- -PERF- -EFFT- -FRUS- -MEAN-     -REMARKS-
#-------------------------------------------------------------------------------------------------------
00:03:25.0 00:12.6   62     33     37     23     58     24    39.50
00:04:45.0 00:14.3   62     64     68     17     58     50    53.17
```

Figure 5-7. The WRS_2011_02112041.txt records the subject’s responses to the Workload Rating Scale

Use of the NASA-TLX can include asking subjects to rate the importance of each of the subscales; these ratings are typically applied as weighting factors for each subscale. The current version of MATB-II currently does not include a weighting application for subjects to make weighting estimates. Weights may be obtained outside this program and applied to the Rating data. Alternatively, there is some research support for the use of a non-weighted NASA-TLX, due to the high correlations shown between using weighted and non-weighted scores (Byers, Bittner, & Hill, 1989; Moroney, Biers, Eggemeier, & Mitchell, 1992).

6 Basic Steps for Initiating a MATB-II Study

Are you ready to conduct an experiment or empirical study using MATB-II?

1. Install the application

   Follow the setup procedures in Section 3 to install MATB-II. Verify that MATB_CONFIG.xml and MATB_EVENTS.xml files are in the \XML subfolder.

2. Retain a copy of the default Configuration and Events file

   Run MATB-II initially with the provided MATB_CONFIG.xml and MATB_EVENTS.xml.

3. Write scripts for the Configuration and Events file and rename with a customized name

   Edit MATB_CONFIG.xml as desired and save. Edit MATB_EVENTS.xml and save with a unique suffix.

4. Save the Configuration file and the Events file in the \MATB\XML folder of the main computer drive

   Verify that your edited MATB_CONFIG.xml and MATB_EVENTS-xxxx.xml files are in the \XML subfolder.

5. Instruct the Subject on how to perform the MATB-II tasks. (See Section 7).
6. Start a run.
7. Get the data files.

   The output files for the run will be in the \Data folder.

8. The data analysis and reporting of the results are up to you.

Happy Experimenting!

- The NASA MATB-II Team

7 Example Instructions to be provided to Subjects for operating MATB-II

The tasks in MATB-II simulate the kinds of tasks that pilots perform during flight. The MATB-II main window contains four different tasks and a scheduling display that allows the preview of the workload. The tasks you will be expected to respond to are the following: monitoring, tracking, communications and resource management (Figure 7-1). A Workload Rating window may also be presented to you at any time during a run, or after a run.

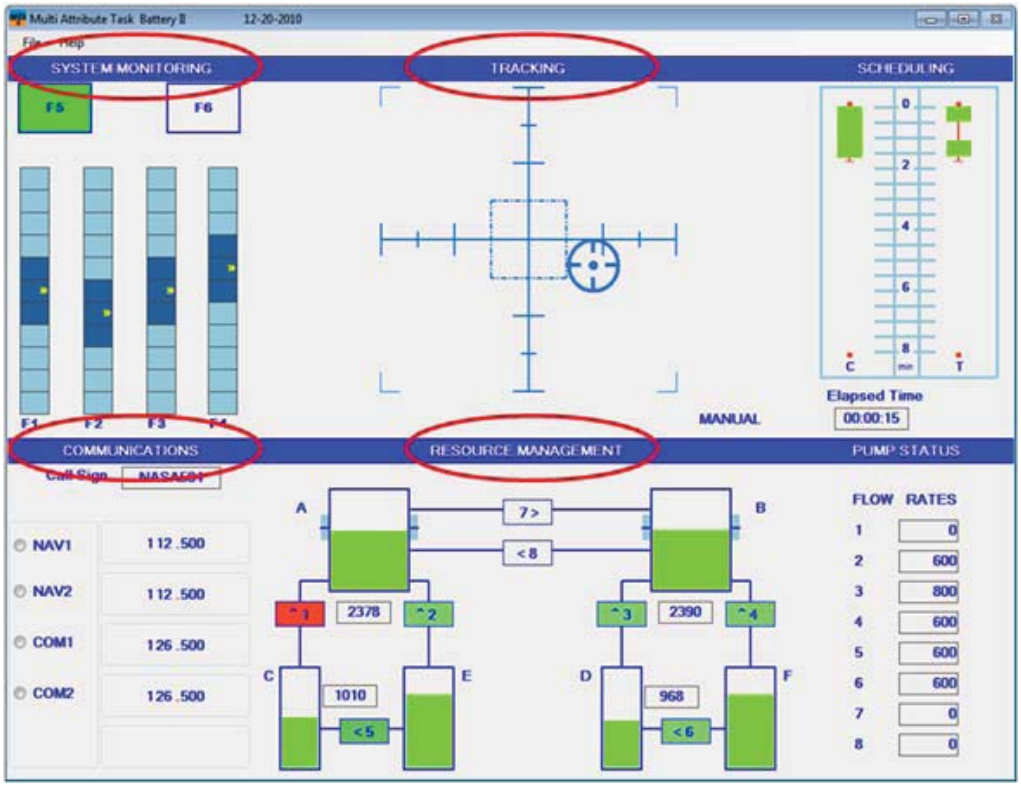


Figure 7-1. MATB-II main window showing the tasks and the Scheduling Display

The MATB-II Graphical User Interface has some features common to the Windows Operating System; however, some commands have been modified or changed. Such commands are presented in Table 7-1.

Table 7-1. Commands to control initiation and exiting of MATB-II

Actions	Commands
START	Click on the Start option of the File Menu or hit CTRL-S
PAUSE	Click on the Pause option of the File Menu CTRL-P
RESUME	Click on the Resume option of the File Menu CTRL-R
QUIT	Click on the Exit option of the File Menu CTRL-X

If you try to close the application by clicking the Close(X) button in title bar, no action will be taken. That button is disabled. The experimenter will inform you if and under what conditions you should use these window controls.

7.1 System Monitoring (SYSMON) Task

The SYSMON task appears in the upper left corner of the Main Application Window and is divided into two sub tasks: the warning lights and the monitoring scales. The warning lights are in the balloon at the top of Figure 7-2 while the scales are in the lower balloon in the upper portion of the panel. During a run, the green light on the left is normally “On.” If the green light should turn “Off”, you are to indicate that you detect this by clicking on it with the mouse, or by pressing the F5 key.

The light on the right is normally “Off”; however, a red light does come on occasionally. Your task is to detect the red light, and to respond by clicking on it with the mouse, or by pressing the F6 key.

Figure 7-2. The System Monitoring (SYSMON) Task

The experimenter will tell you if the mouse or a keyboard method is preferred, or if it doesn't matter which method you use.

The second part of the system monitoring task involves monitoring four scales with lights that normally fluctuate around the center of the scale, usually within one unit in each direction from the center. Your goal is to make sure that the lights on the scales keep fluctuating around the center of the scale. If you notice that the lights in a particular scale have an offset (it looks too high or too low), you must click on the scale that has the offset, or press the function key that correspond to that scale using the keyboard (F1, F2, F3, F4), according to experimenter instructions.

7.2 Tracking (TRACK) Task

The upper central region of the MATB-II window contains the tracking task. Your job is to keep the target in the center of the rectangular box when the task is in the MANUAL mode. The current mode is displayed as either "MANUAL" or "AUTO ON" in the lower right corner of the window. When the mode changes between AUTO and MANUAL, the grid changes color from a lighter shade of blue to a darker shade of blue (Figure 7-3).

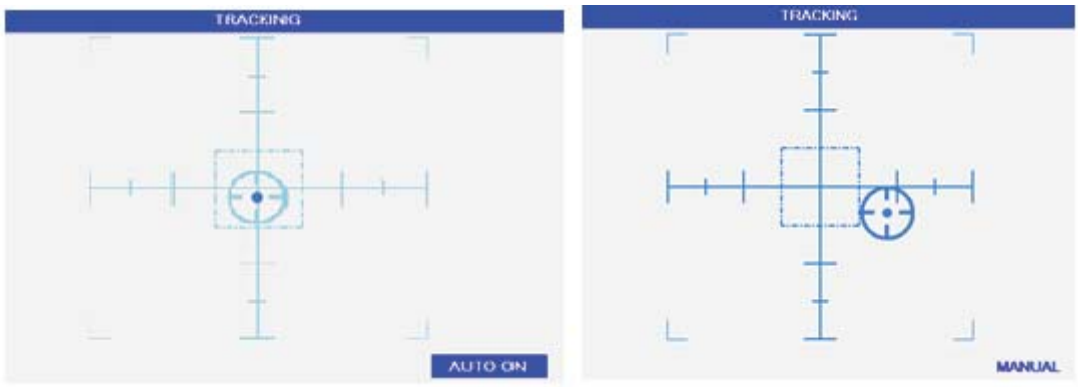


Figure 7-3. Grid changes color when the tracking mode transitions from Auto to Manual

The overall purpose of this task is to keep the aircraft (represented by a blue circle) within the dotted rectangular area in the center of this task. Try to maintain this at all times. You control the aircraft with movements of the joystick. If you do not control the aircraft with the joystick, it will drift away from the center. If the aircraft leaves the rectangular area, try to bring the aircraft back to center as quickly as possible.

7.3 Communications (COMM) Task

The lower left region of the MATB-II main window contains the communications task. You will hear messages that call a particular aircraft by a "call sign" assigned to it. The call sign for your aircraft is "NASA 504". You must respond only when you hear this call sign. Call signs will be presented twice to help you determine if you must respond. Other call signs will be presented in the same way.

When you receive an ATC message, it will contain two parts. The first part of the message is the call sign for a particular aircraft (or ship). The second part of the message is a command requiring you to tune one of the four radios to a particular frequency. The four radios are NAV1, NAV2, COM1 and COM2. To change the

frequency, select the appropriate radio and use the arrows to set the correct frequency. Figure 7-4 shows the elements of the communications task.

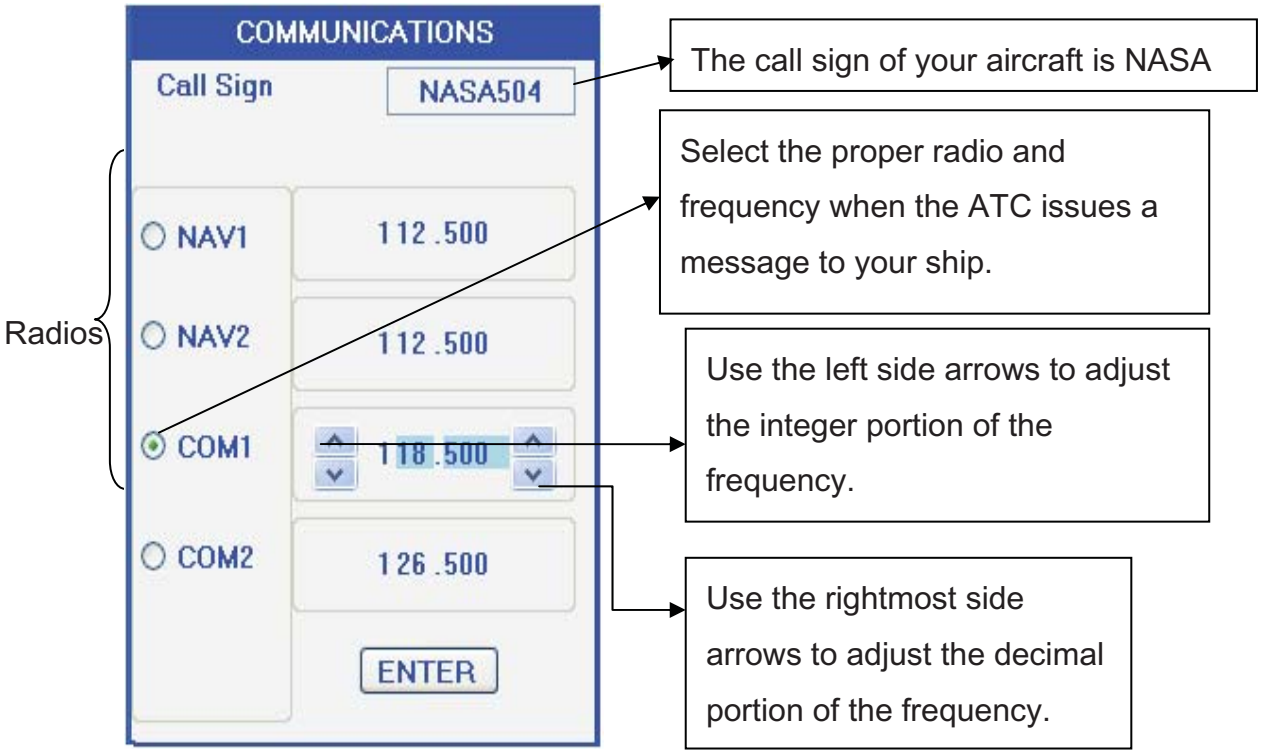


Figure 7-4. Selecting a frequency in the COMM task

Remember, the overall goal of this task is to correctly distinguish messages beginning with your call sign from those with other call signs and respond to those commands. Please respond as quickly and accurately as you can.

7.4 Resource Management (RESMAN) task

The lower right region of the MATB-II main window contains the resource management task. Figure 7-5 displays the elements that comprise this task. The rectangular regions identified with the letters A-F represent fuel tanks. The green levels within the tanks represent fuel levels. Along the lines which connect the tanks are pumps which transfer fuel from one tank to another in the direction indicated by the arrows.

There are 8 pumps labeled with the numbers 1-8. Each one of the pumps is represented by a rectangular box with a number inside it that identifies the pump, and an arrow that indicates the direction of the fuel. The pumps are used to transfer fuel from the supply tanks to the main tanks.

Deactivated pumps are colored in gray [^ 1], activated pumps are green [^ 2], and failed pumps are red [< 5]. Note in Figure 7-5 that pumps 1, 2, 4 and 6 are active, pumps 3, 7 and 8 are inactive, and pump 5 is failed.

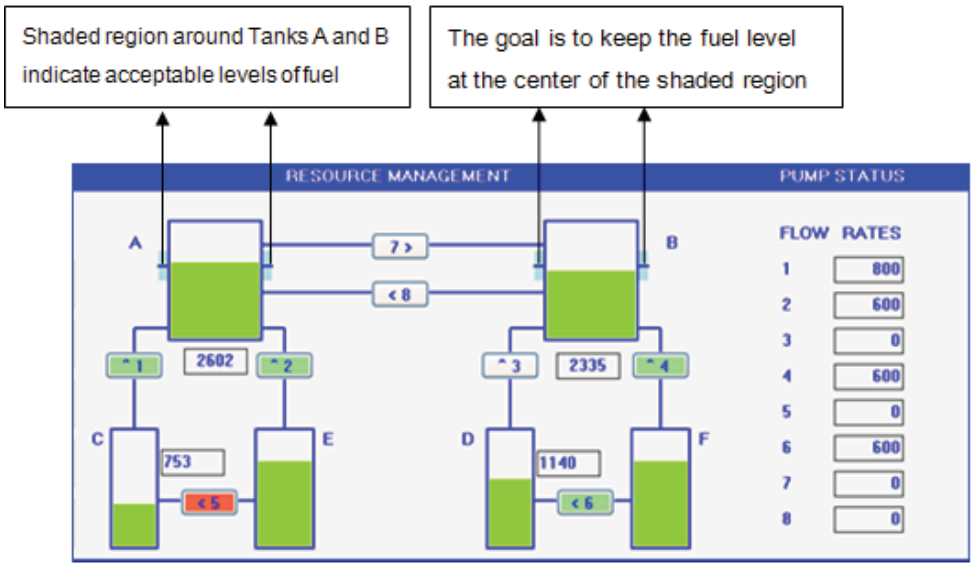


Figure 7-5. The Resource management task

When a pump activates, the numbers change in the "Pump Status" area. Under "Pump Status", two columns of numbers are present. In the first column, numbers 1 through 8, correspond directly to the pumps in the diagram. The second column indicates the flow rate in units per minute for each pump when it is on.

In Figure 7-6, the numbers underneath tanks A and B and to the right of tanks C and D represent the amount of fuel for each of those tanks. Those numbers will be increasing and decreasing as the fuel levels change. The capacity for the main tanks, A and B, is 4000 units each. The supply tanks, C and D, contain a maximum of 2000 units each. Tanks E and F are supply tanks that have an unlimited capacity - they never run out. The areas shaded in light blue on the side of tanks A and B indicate the critical levels of fuel for those tanks. You must transfer fuel to tanks A and B in order to meet these criteria because the fuel in tanks A and B is consumed.

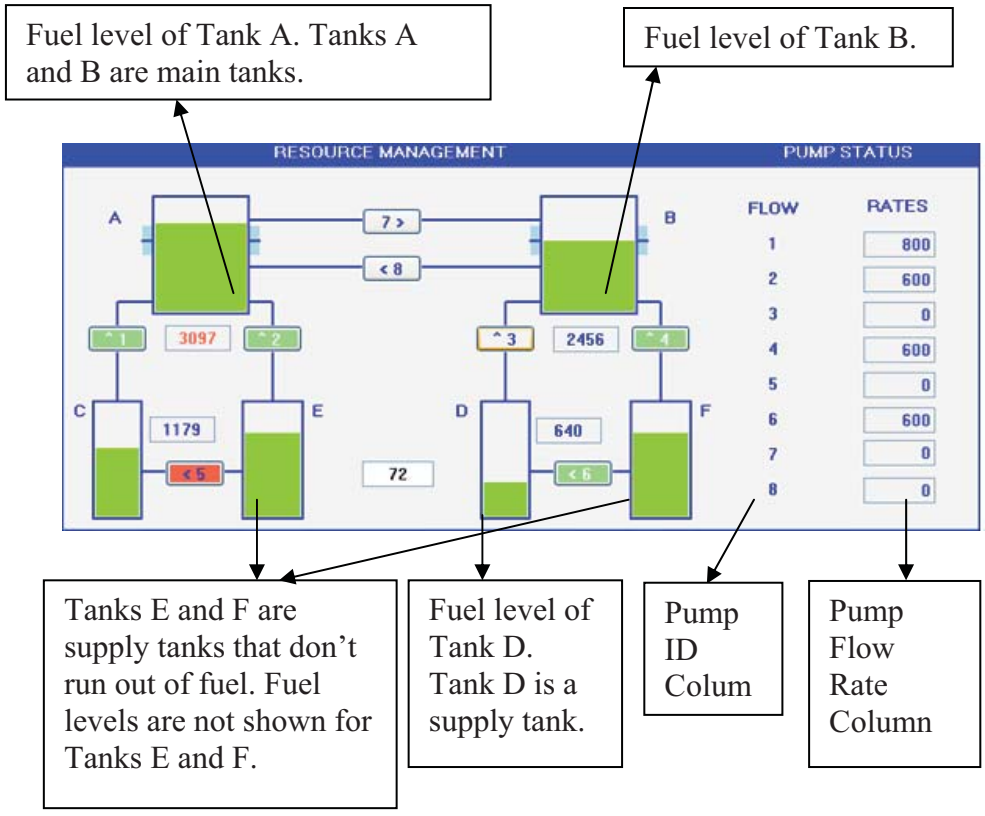


Figure 7-6. Explanation of the task elements of the RESMAN

When the resource management task begins, the fuel level for Tanks A and B is at 2500 units. You are to keep the level of fuel from dropping below this level as indicated by the marker on either side of these pumps. As time passes, tanks A and B lose fuel. These tanks would eventually become empty without the transfer of additional fuel. Tanks C and D only lose fuel if they are transferring fuel to another tank.

Let's consider the process of transferring fuel. Each pump can only transfer fuel in the direction indicated by the ^ arrow in its label. The pumps are activated by either clicking on them, or by pressing the number key corresponding to the pump that you wish to activate. A pump is actively transferring fuel when it turns green.

So far, you've seen two conditions for the pumps: ON and OFF. If you either click with the mouse or press the pump number on the keyboard just once, you will turn the pump ON [^ 2]; clicking or pressing the key again turns that pump OFF [^ 2], and so on. If a tank fills up to its capacity, all incoming pump lines will be turned off automatically. This is because a full tank cannot receive any more fuel. You will have to turn those pumps back on at a later time, if the fuel level of the tanks goes below the critical level. Furthermore, if a tank becomes empty, all outgoing pumps will automatically be turned off. This is because an empty tank can no longer transfer fuel. In that case, the proper action is to supply fuel to an empty tank before turning on the pump that transfers fuel out of it (Figure 7-7).

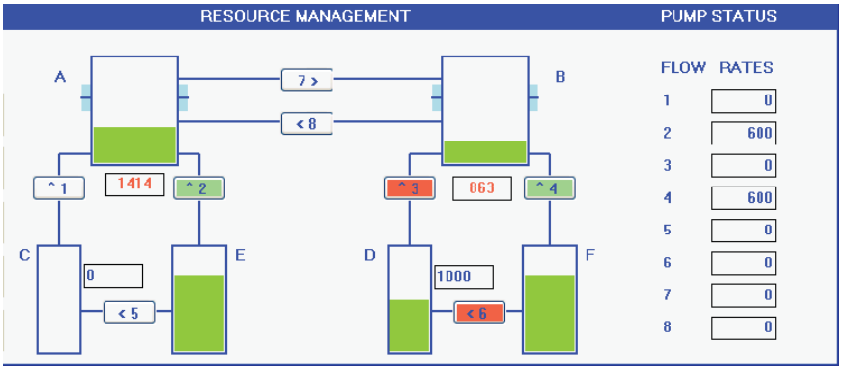


Figure 7-7. When Tank C runs out of fuel, pump 1 is turned off

At some point during the execution of the resource management task, one or more of the pumps may fail. When a pump fails, its label turns red. Depending on the level of fuel in the tank affected, you might need to transfer fuel from one main tank to another main tank to compensate for the loss of fuel. You can cross feed fuel from one main tank to the other by activating either pump 7 or 8 (Figure 7-8).

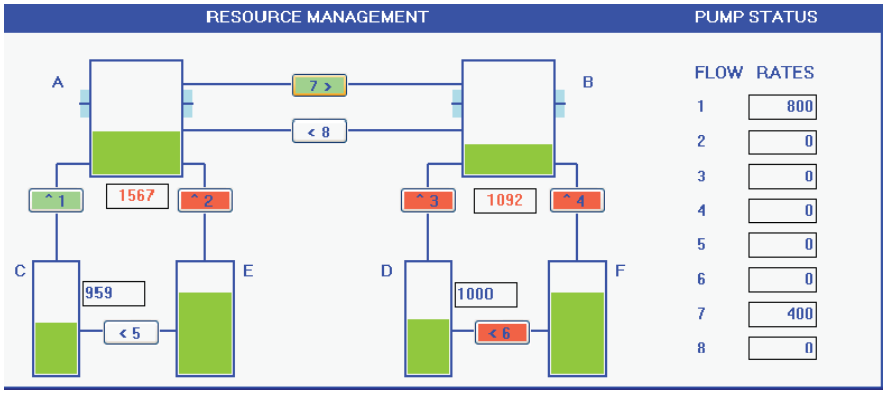


Figure 7-8. Cross feeding fuel from Tank A to Tank B

If you have questions, please interrupt your reading and ask for assistance.

Once again, the overall goal is to maintain the fuel level in tanks A and B close to 2500 units each for as long as you possibly can. There may be more than one way to achieve this goal; you may use the method that works best for you. If the fuel level in these tanks should deviate from this level, please return the fuel level back to this point as soon as possible.

7.5 Scheduling Display (SCHED)

The purpose of the scheduling display (Figure 7-9) is to depict the start and duration of the manual tracking task and the communications task. The two indicators are "T" for the TRACK task and “C" for the COMM task. The scheduling display allows the subject to "look ahead" from 0 (present) to 8 minutes into the future. The bold lines (thick green bars) indicate the time at which these two tasks begin. The thin red lines indicate times at which either tracking or communications

actions are not required of the subject. In MATB-II the time is tracked by the elapsed timer using the notation hh:mm:ss. For example, 1 hour, 35 minutes and 30 seconds is represented as 01:35:30.

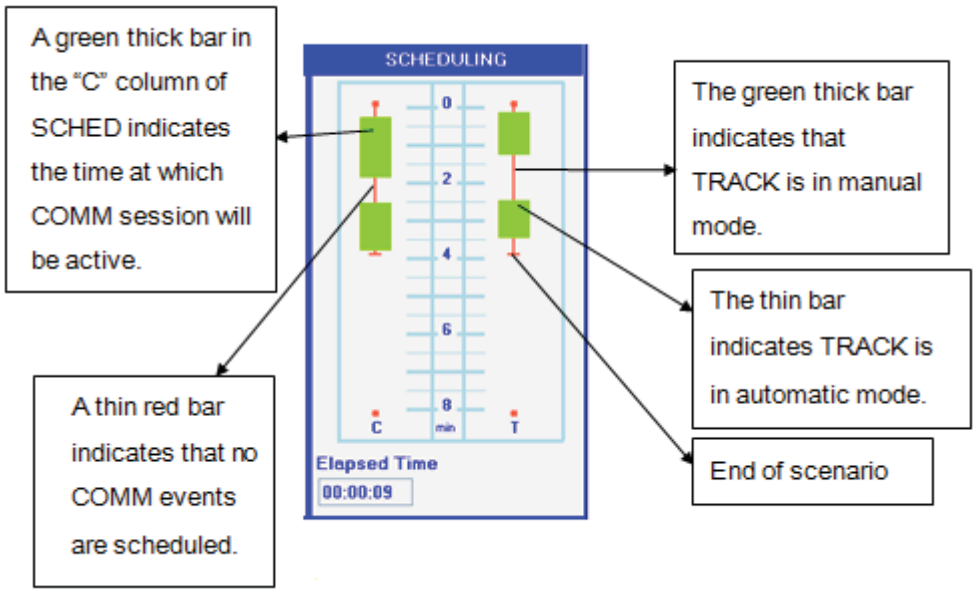


Figure 7-9. The Scheduling Display

7.6 Workload Rating Scale (WRS)

The WRS can be presented to you at any time during the operation of the Multi-Attribute Task Battery (Figure 7-10). You must move each one of the sliders in order to activate the "Save All" button that is used to submit your answers. After a certain time, usually 30 seconds, the window disappears (a timeout occurs). Upon return to the MATB-II screen, the simulation resumes. Once again, you will need to move each one of the sliders of the subscales to be able to submit your responses.

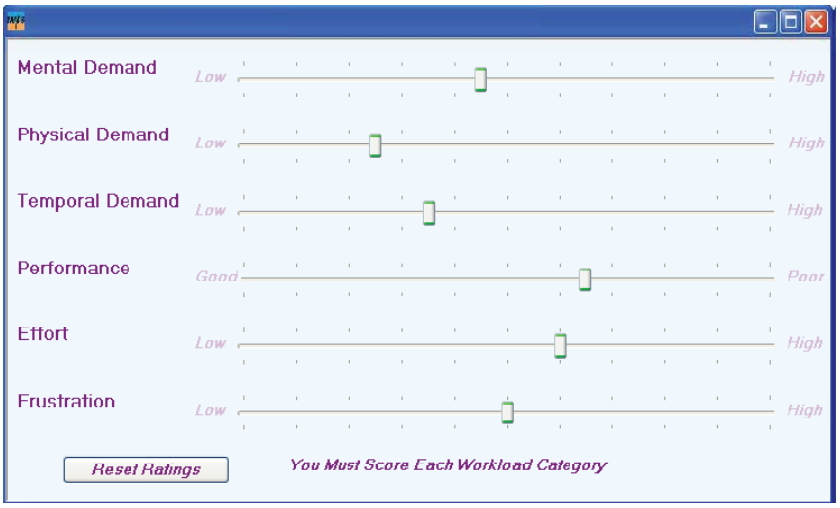


Figure 7-10. The Workload Rating Scale

The NASA Task Load Index was developed by the Human Performance Group at NASA Ames Research Center (Hart and Staveland, 1988). It uses six subscales to provide an overall workload rating: Mental Demand, Physical Demand, Temporal Demand, Own Performance, Effort and Frustration. The Own Performance subscale ranges from "Good" to "Poor." The other five subscales range from "Low" to "High". The meaning of each Rating scale is explained in Table 7-2.

Table 7-2. Explanation of the terms used in the Workload Rating Scale

Terms used in the Rating scales	Explanation
Mental demand	The level of mental activity required to perform the tasks.
Physical demand	The amount of physical activity required to perform the task
Temporal demand	Time pressure that you experienced (slow or rapid pace)
Performance	How well you think you performed
Effort	How hard you worked to achieve your level of performance
Frustration	How did you feel while performing the tasks, ranging from relaxed to very stressed

Now that you have read how to use the Multi-Attribute Task Battery, you are ready to interact with it. Ask the person in charge of this test to initiate the MAT Battery.

Thanks for your time.

8 References

Arnegard, R.J. (1991). *Operator strategies under varying conditions of workload*. National Aeronautics and Space Administration, Langley Research Center, NASA CR-4385.

Byers, J. C., Bittner, A. C., & Hill, S. G. (1989). Traditional and raw task load index (TLX) correlations: Are paired comparisons necessary? In A. Mital (Ed.), *Advances in Industrial Ergonomics & Safety* (Vol. 1, pp. 481-485). London: Taylor & Francis.

Comstock, J.R & Arnegard, R.J. (1992). *The Multi-attribute Task Battery for human operator workload and strategic behavior research.* National Aeronautics and Space Administration, Langley Research Center, NASA TM-104174.

Hart S. G., and Staveland, L. E. (1988). Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In P. A. Hancock and N. Meshkati (Eds.), *Human mental workload*. Amsterdam: North Holland Press.

Lissajous pattern. (2000). In *The Communications Facility Design Handbook* (online): CRC Press. doi:10.1201/9781420041446

Moroney, W.F., Biers, D.W., Eggemeier, F.T., and Mitchell, J. (1992). A comparison of two scoring procedures with the NASA Task Load Index in a simulated flight task. In *Proceedings of the IEEE 1992 National Aerospace and Electronics Conference* (Vol. 2, pp. 734-740). Dayton, OH: NAECON.

Search path. (2002). In *Microsoft computer dictionary*, fifth edition. Retrieved from http://common.books24x7.com/book/id_6846/book.asp.

Westermann, E. (2002). *Learn XML in a Weekend*. Retrieved from http://common.books24x7.com/book/id_4216/book.asp.

9 MATB Reference List (Selected Publications From 2003-2010)

1. Armstead, A. G., & Henning, R. A. (2007). Effects of long audio communication delays on team performance. In *Proceedings of the Human Factors and Ergonomics Society 51st Annual Meeting*, Communications, (pp. 136-140). Santa Monica, CA: Human Factors and Ergonomics Society.

2. Backs, R. W., Rohdy, J., & Barnard, J. (2005). Cardiac control during dual-task performance of visual or auditory monitoring with visual-manual tracking, *Psychologia* ,48, 66-83.

3. Bagheri, N., & Jamieson, G. A. (2004). Considering subjective trust and monitoring behaviour in assessing automation-induced 'complacency'. In *Proceedings of the Human Performance, Situation Awareness and Automation Technology Conference*, Vol. 2, (pp. 54-59). Marietta, GA: SA Technologies.

4. Bagheri, N., & Jamieson, G. A. (2004). The impact of context-related reliability on automation failure detection and scanning behaviour. In *Proceedings of the IEEE 2004 International Conference on Systems, Man and Cybernetics*, (pp. 212-217). Piscataway, NJ: IEEE. doi:10.1109/ICSMC.2004.1398299

5. Bagheri, N., & Jamieson, G. A. (2004). An optimal sampling model to ascertain automation-induced complacency in multi-tasks environments. In *Proceedings of the IFIP Working Conference on Human Error, Safety and System Development,* (pp.131-145). Boston, MA: Kluwer Academic.

6. Bailey, N. R., Scerbo, M. W., Freeman, F. G., Mikulka, P. J., & Scott, L. A. (2006). Comparison of a brain-based adaptive system and a manual adaptable system for invoking automation, *Human Factors*, *48*(4), 693-709.

7. Bliss, J. P., Fallon, C. K., & Nica, N. (2007). The role of alarm signal duration as a cue for alarm validity. *Applied Ergonomics*, *38* (2), 191-199. doi:10.1016/j.apergo.2006.03.004

8. Caldwell, J. A., Caldwell, J. L., Brown, D., Smythe, N., Smith, J., Mylar, J., . . . Schroeder, C. (2004). The effects of 37 hours of continuous wakefulness on the physiological arousal, cognitive performance, self-reported mood, and simulator flight performance of F-117A pilots. Texas: United States Air Force Research Laboratory, Human Effectiveness Directorate, Biodynamics and Protection Division, Flight Motion Branch, Brooks City-Base.

9. Carlozzi, N.E., Horner, M.D. , Kose, S., Yamanaka, K., Mishory, A., Qiwen, M., . . . George, M.S. (2009). Personality and reaction time after sleep deprivation. *Current Psychology*, *29* (1), 24-33. doi:10.1007/s12144-009-9068-8

10. Cerruti, L., Christensen, J., Estepp, J., & Miller, W. (2010). *Transcranial doppler assessment of workload transition in a complex task.* Paper presented at the Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, CA.

11. Clark, R. M., Ingebritsen, A. M. I., & Bustamante, E. A. (2010). *Differential effects of likelihood alarm technology and false-alarm vs. miss-prone automation on decision-making accuracy and bias*. Paper presented at the Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, CA.

12. Davenport, R. B., & Bustamante, E. A. (2010). *Effects of false-alarm vs. miss-prone automation and likelihood alarm technology on trust, reliance, and compliance in a miss-prone task.* Paper presented at the Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, CA.

13. Estepp, J. R., Monnin, J. W., Christensen, J. C., & Wilson, G. (2010). *Evaluation of a dry electrode system for electroencephalography: Applications for psychophysiological cognitive workload assessment*. Paper presented at the

Human Factors and Ergonomics Society 54th Annual Meeting, San Francisco, CA.

14. Fairclough, S. H., & Venables, L. (2006). Prediction of subjective states from psychophysiology: A multivariate approach. Biological Psychology, 71(1), 100-110.

15. Fairclough, S. H., Venables, L.& Tattersall, A. (2005). The influence of task demand and learning on the psychophysiological response. *International Journal of Psychophysiology*, Vol. 56(2), 171-184. doi:10.1016/j.ijpsycho.2004.11.003

16. Fairclough, S. H., Venables, L., & Tattersall, A. J. (2006). The use of autonomic measures for biocybernetic adaptation. *Psychophysiology, 42* (S1), S25.

17. Gawron, V. J. (2008). *Human performance, workload ad situational awareness measures handbook*: Taylor and Francis. Retrieved at http://books.google.com

18. González, C. (2005). Task workload and cognitive abilities in dynamic decision making. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *47*, 92-101. doi:10.1518/0018720053653767

19. Haarmann, A. (2007). *Der Einsatz psychophysiologischer Variablen bei der adaptiven automatisierung am Beispiel einer Flugsimulationsaufgabe [Application of psychophysiological measures for adaptive automation during simulated flight].* (Doctoral dissertation, University of Wuppertal).

20. He, P., Wilson, G., Russell, C., & Gerschutz, M. (2007). Removal of ocular artifacts from the EEG: a comparison between time-domain regression method and adaptive filtering method using simulated data. *Medical & Biological Engineering & Computing, 45* (5), 495-503. doi:10.1007/s11517-007-0179-9

21. Klöpping, W., Jonkman, A, Valk, P., Simons, M. (2005). Efficacy of modafinil and caffeine to counteract hypnotic induced sleepiness during sustained operations. In *Strategies to Maintain Combat Readiness during Extended Deployments – A Human Systems Approach* (pp. 32-1 – 32-6). Meeting Proceedings RTO-MP-HFM-124, Paper 32. Neuilly-sur-Seine, France: RTO. Retrieved from http://ftp.rta.nato.int/public/PubFullText/RTO/MP/RTO-MP-HFM-124/MP-HFM-124-32.pdf

22. Kourtidou-Papadeli, C., Papadelis, C., Koutsonikolas, D., Boutzioukas, S., Styliadis, C., & Guiba-Tziampiri, O. (2008). High altitude cognitive performance and COPD interaction. *Hippokratia, 12* (Suppl 1), 84-90. Retrieved from http://ukpmc.ac.uk/articles/PMC2577408

23. McKinley, R. A., McIntire, L.K. & Funke, M. A. (2009). *Operator selection for unmanned aerial vehicle operators: a comparison of video game players and manned aircraft pilots*. Ohio: Air Force Material Command, Air Force Research Laboratory, 711th Human Performance Wing, Human Effectiveness Directorate, Biosciences and Performance Division, Vulnerability Analysis Branch, Wright-Patterson AFB. Retrieved from http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA518309&Location=U2&doc=GetTRDoc.pdf

24. Miao, T. S., Toshiyuki, S., Miyake, S., Hashimoto, M. & Simoyama, O. (2003). Alterations of complexity measures during subsidiary task in multi-attribute operations. *Human Interface, 2003*, 791-792.

25. Miyake, S., Yamada, S., Shoji, T., Takae, Y., Kuge, N., & Yamamura, T. (2009). Physiological responses to workload change. A test/retest examination. *Applied Ergonomics, 40* (6), 987-996.

26. Papadelis, C., Kourtidou-Papadeli, C., Bamidis, P., & Albani, M. (2007). Effects of imagery training on cognitive performance and use of physiological measures as an assessment tool of mental effort. *Brain and Cognition*, *64*(1), 74-85.

27. Phillips, C. A., Repperger, D. W., Kinsler, R., Bharwani, G., & Kender, D. (2007). A quantitative model of the human-machine interaction and multi-task performance: A strategy function and the unity model paradigm. *Computers in Biology and Medicine*, *37* (9), 1259-1271. doi:1016/j.compbiomed.2006.12.007

28. Pratt, E., & Holzworth, R. J. (2005). *Individual difference effects on performance in a complex, multi-decision-making environment.* Paper presented at the Proceedings of the Human Factors and Ergonomics Society 49th Annual Meeting.

29. Simons, R., Valk, P. J. L., & Krul, A. J. (2005). Malaria prophylaxis for aircrew: Safety of atovaquone/proguanil in healthy volunteers under aircraft cabin pressure conditions. *Journal of Travel Medicine*, *12* (4), 210-216.

30. Singh, A. L., Tiwari, T., & Singh, I. L. (2010). Performance feedback, mental workload and monitoring efficiency. *Journal of the Indian Academy of Applied Psychology*, *36*, 1. Retrieved from http://medind.nic.in/jak/t10/i1/jakt10i1p151.pdf

31. Singh, I. L. S., Sharma, H. O., & Singh, A. L. (2005). Effect of training on workload in flight simulation task performance. *Journal of the Indian Academy of Applied Psychology*, *31*, 83-91.

32. Singh, I. L. S., Sigh, A. L., & Saha, P. K. (2007, July 22-27). *Monitoring performance and mental workload in an automated system.* Paper presented at the 7th International Conference on Engineering Psychology and Cognitive Ergonomics, EPCE 2007, Held as Part of HCI International 2007, Beijing, China.

33. Smith, S. D. , & Jurcsisn, J. G. (2010). *Cushion effects during low frequency jet aircraft vibration exposure*. Ohio: Air Force Material Command, Air Force Research Laboratory, 711th Human Performance Wing, Human Effectiveness Directorate, Biosciences and Performance Division, Vulnerability Analysis Branch, Wright-Patterson AFB. Retrieved from http://dodreports.com/pdf/ada522250.pdf

34. Spain, R. D., Bliss, J. D., & Newlin, E. T. (2007). The effect of sonification pulse rate on perceived urgency and response behaviors. Proceedings of the Human Factors and Ergonomics Society 51st Annual Meeting, 1345-1348. Santa Monica, CA: Human Factors and Ergonomics Society

35. Valk, P. J. L. (2004). Desloratadine shows no effect on performance during 6 h at 8,000 ft simulated cabin altitude. *Aviation, Space, and Environmental Medicine*, *75* (5), 433-438.

36. van Dorp, E., Los, M., Dirven, P., Sarton, E., Valk, P., Teppema, L., . . . Dahan, A. (2007). Inspired carbon dioxide during hypoxia: Effects on task performance and cerebral oxygen saturation. *Aviation, Space, and Environmental Medicine*, *78* (7), 666-672.

37. Voorheis, C. M. (2006; 2004 (original thesis)). *Context effects on subjective workload assessments using the Multi-attribute Task Battery tracking task: An extension of Voorheis*. Unpublished Master, University of Dayton.

38. Voorheis, C. M., Moroney, W. F., Biers, D. W., & Eggemeier, F. T. (2005). *In search of workload context effects using a compensatory tracking task*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society 49th Annual Meeting.

39. Weaver, J. L., Bradley, K.A., Hancock, P.A., Szalma, J.L., & Helmick, J. A. (2003). *Skills, rules, & knowledge: An experimental test of performance decrements as*

a function of stressor exposure. Paper presented at the 12th International Symposium on Aviation Psychology. Dayton, OH: University of Central Florida.

40. Wilson, G. F., & Russell, C. A. (2003). Real-time assessment of mental workload using psychophysiological measures and artificial neural networks. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *45* (4), 635-644 doi:10.1518/hfes.45.4.635.27088

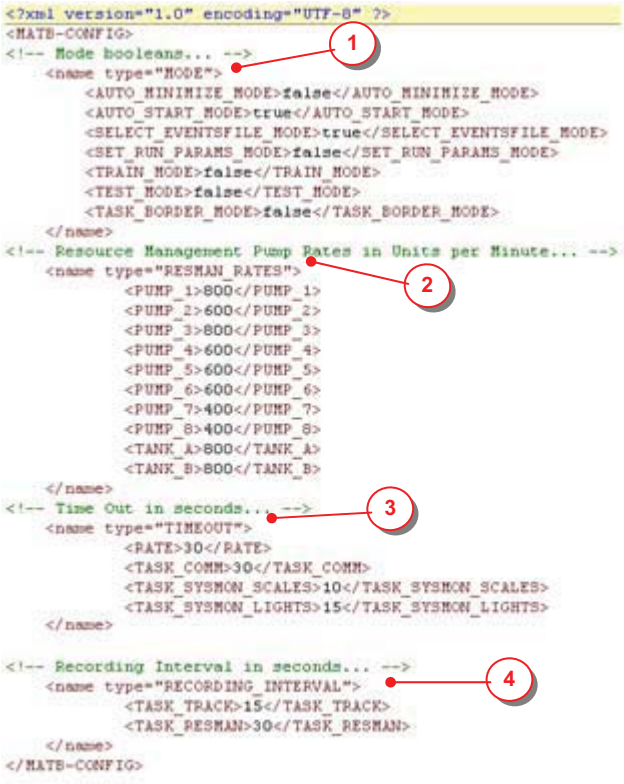
41. Wilson, G. F., Russell, C. A., Monnin, J. W., Estepp, J. R. & Christensen, J.C. , (2010). How does day-to-day variability in psychophysiological data affect classifier accuracy? In *Human Factors and Ergonomics Society Annual Meeting Proceedings,* Augmented Cognition, (pp. 264-268). Santa Monica, CA: Human Factors and Ergonomics Society.

User's Guide Appendix to the Multi-Attribute Task Battery Technical Memorandum

A MATB Configuration File

The filename of the MATB configuration file is ***MATB_CONFIG.xml***. This file contains four different types of configuration data used by the application. First is a set of seven Boolean modes which selectively control the functionality of MATB based upon user desires. Second are the resource management task (**RESMAN**) pump volumetric values and main tank consumption rates in units per minute. Next is a set of timeout values in seconds for the communications (**COMM**) and system monitoring (**SYSMON**) tasks. The lights and scales have independent timeout values. The workload rating questionnaire also has a timeout value. If the subject does not respond within the time period the event expires and an appropriate entry is made to the output file. Lastly, certain tracking and resource management state data is recorded at the time interval specified. For the tracking (**TRACK**) task, the Root Mean Square Deviation from the Center Point in Pixel Units (RMSD-C) is calculated and recorded along with the number of samples during the interval. For the resource management task, the tank volumes and pumps state are recorded at the end of each time interval. This is in addition to the entries made when the subject turns a pump on or off.

A.1 MATB_CONFIG.xml



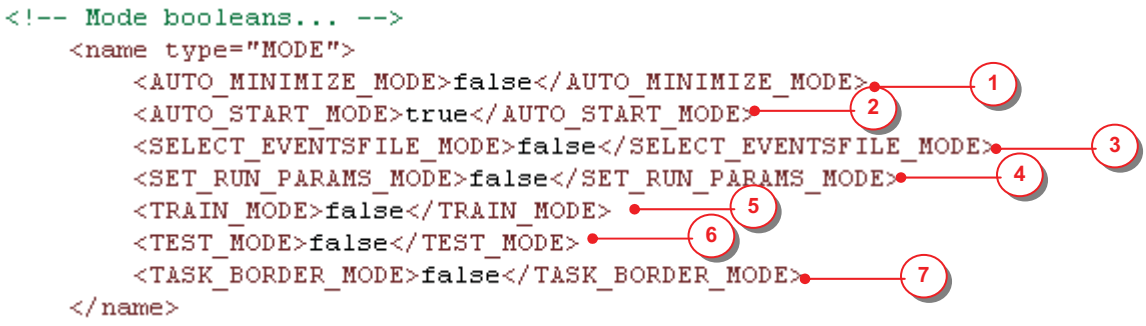

```
<?xml version="1.0" encoding="UTF-8" ?>
<MATB-CONFIG>
<!-- Mode booleans... -->
    <name type="MODE">
        <AUTO_MINIMIZE_MODE>false</AUTO_MINIMIZE_MODE>
        <AUTO_START_MODE>true</AUTO_START_MODE>
        <SELECT_EVENTSFILE_MODE>true</SELECT_EVENTSFILE_MODE>
        <SET_RUN_PARAMS_MODE>false</SET_RUN_PARAMS_MODE>
        <TRAIN_MODE>false</TRAIN_MODE>
        <TEST_MODE>false</TEST_MODE>
        <TASK_BORDER_MODE>false</TASK_BORDER_MODE>
    </name>
<!-- Resource Management Pump Rates in Units per Minute... -->
    <name type="RESMAN_RATES">
            <PUMP_1>800</PUMP_1>
            <PUMP_2>600</PUMP_2>
            <PUMP_3>800</PUMP_3>
            <PUMP_4>600</PUMP_4>
            <PUMP_5>600</PUMP_5>
            <PUMP_6>600</PUMP_6>
            <PUMP_7>400</PUMP_7>
            <PUMP_8>400</PUMP_8>
            <TANK_A>800</TANK_A>
            <TANK_B>800</TANK_B>
    </name>
<!-- Time Out in seconds... -->
    <name type="TIMEOUT">
            <RATE>30</RATE>
            <TASK_COMM>30</TASK_COMM>
            <TASK_SYSMON_SCALES>10</TASK_SYSMON_SCALES>
            <TASK_SYSMON_LIGHTS>15</TASK_SYSMON_LIGHTS>
    </name>

<!-- Recording Interval in seconds... -->
    <name type="RECORDING_INTERVAL">
            <TASK_TRACK>15</TASK_TRACK>
            <TASK_RESMAN>30</TASK_RESMAN>
    </name>
</MATB-CONFIG>
```

Item #	Name Type	Description
1	MODE	Seven Booleans modes set the functionality of MATB.
2	RESMAN RATES	The rates per minute of each of the eight pumps and the consumption rates per minute of the primary tanks.
3	TIMEOUT	Timeout values in seconds for the Workload Rating Scale, COMM and SYSMON tasks.
4	RECORDING INTERVAL	The recording interval in seconds for the TRACK and RESMAN tasks.

A.2 MATB Modes

The seven modes are:
1. “Automatic Minimize” when another application takes the focus away from MATB.
2. “Automatic Start” of a run once initialization is completed.
3. “Select Eventsfile” from a file dialog and not default to ***MATB_EVENTS.xml***.
4. “Set Run Parameters” provides a dialog of sliders to overload the values in the ***MATB_CONFIG.xml***. Intended for use during experiment design.
5. “Training Mode” provides visual cues and menu choices to the subject not normally available during a data collection run.
6. “Test Mode” provides visual cues and menu choices to the experiment designer not normally available during a data collection run.
7. “Task Border Mode” adds a blue column between the tasks to serve as a visual separator when set to True. As glass flight deck aircraft do not use these types of separators, the default is false.



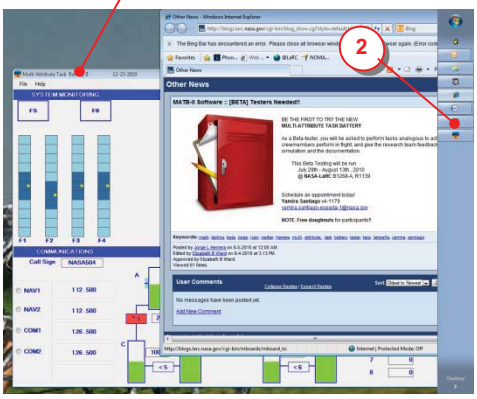
Item #	Mode Name	Description
1	Auto Minimize	When **true** MATB will automatically minimize if it loses the focus to another process. For making screen captures, the value must be **false**.
2	Auto Start	When **true** the run automatically starts, but when **false** a dialog asks the user for acknowledgement to start the run. During training it may be useful to set to **false**, but during data collection normally this mode should be **true**.
3	Select Events file	Provides the option to select an events file other than “MATB_EVENTS.xml” in the format “MATB_EVENTS-xxxxxx.xml” where “xxxxxx” is a user assigned suffix to indentify the file contents.
4	Set Run Parameters	Allows the user to overload the resource management task pump rate and tank consumption values. Uses sliders so the user may enter a value outside the defined range. Also allows the same for timeouts and recording intervals.
5	Training	Adds a “Train” menu which allows the user to play sample communications task audio files and complete a workload rating evaluation. Additionally, displays visual cues within white text boxes not available when not training or testing.
6	Testing	Adds a “Test” menu which allows the experiment designer to verify that the sound card and joystick are installed and working. Event and configuration values for the run may also be verified. Additionally displays visual cues within white text boxes not available when not training or testing.
7	Task Borders	Adds blue columns on either side of the TRACK task and between the COMM and RESMAN tasks.

A.2.1 MATB Auto Minimize Mode

```
<AUTO_MINIMIZE_MODE>true</AUTO_MINIMIZE_MODE>
```

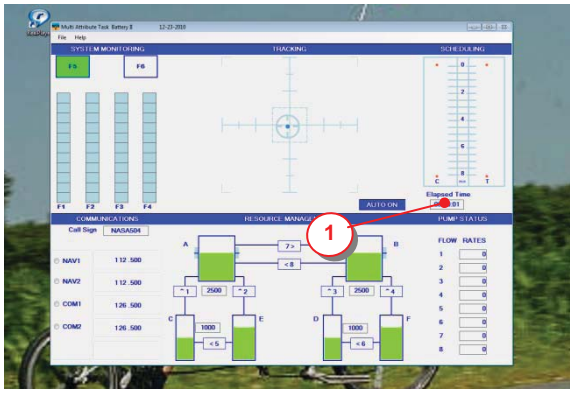
Item #	Boolean	Description
1	true	When another process (the browser in this case) gets the focus, MATB minimizes to the tray. The timers are paused.
2	false	When another process (the browser in this case) gets the focus, MATB remains on the screen. The timers are paused.

```
<AUTO MINIMIZE MODE>false</AUTO MINIMIZE MODE>
```

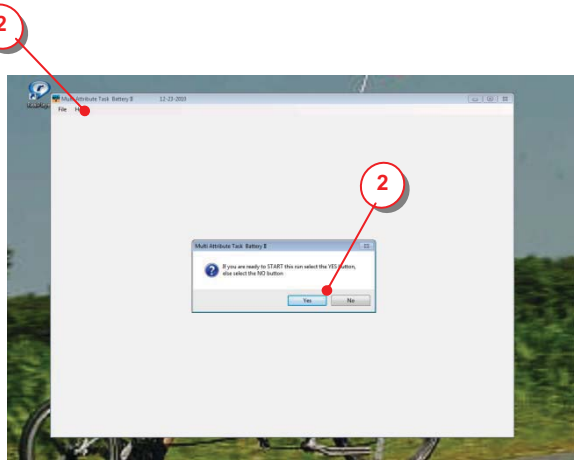


A.2.2 MATB Auto Start Mode

```
<AUTO_START_MODE>true</AUTO_START_MODE>
```

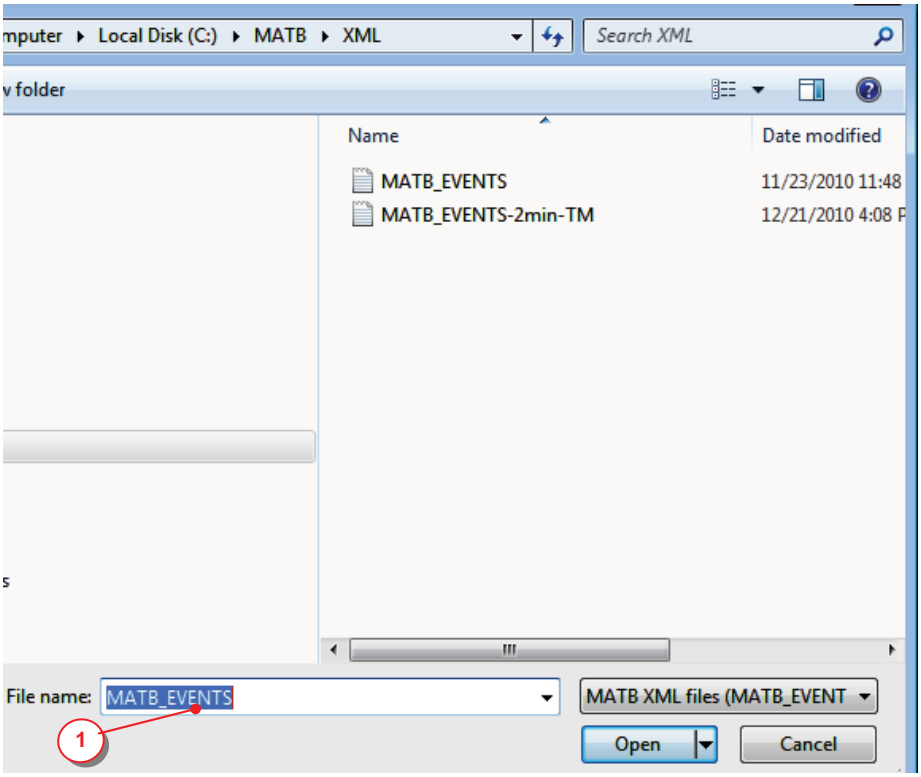


Item #	Boolean	Description
1	true	Run elapsed timer starts as soon as MATB is initialized.
2	false	User starts the application by selecting *Start* from the *File* menu, followed by selecting *Yes* on the dialog.




```
<AUTO_START_MODE>false</AUTO_START_MODE>
```

A.2.3 MATB Select Events File Mode

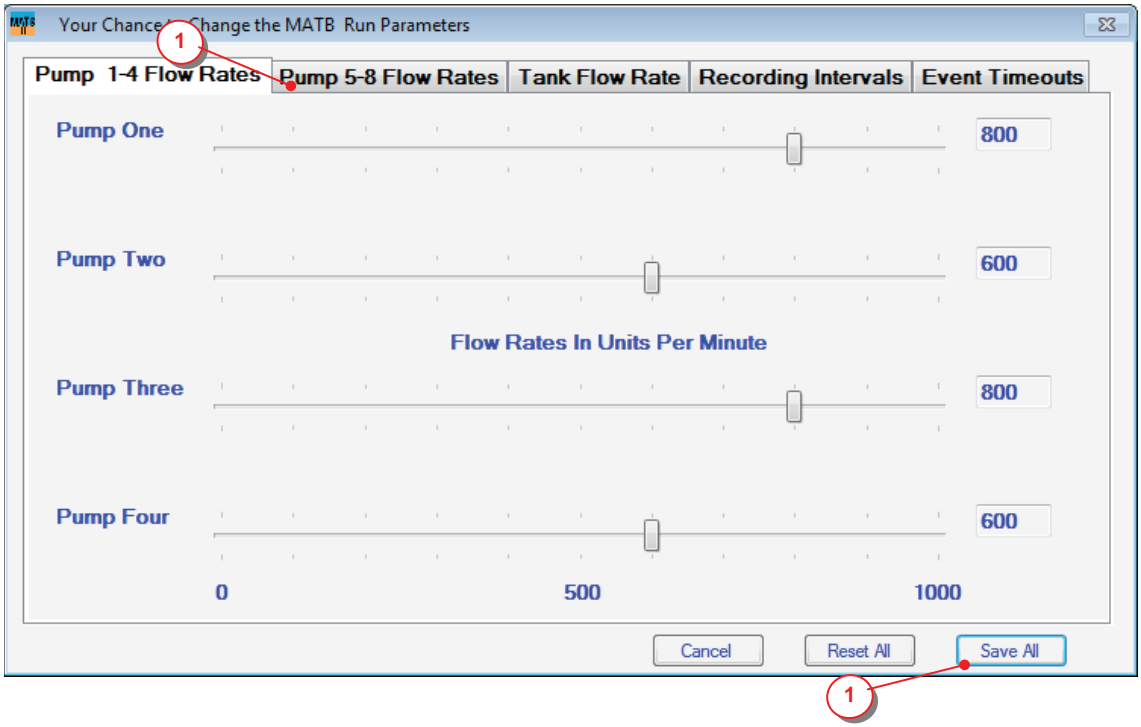



```
<SELECT_EVENTSFILE_MODE>true</SELECT_EVENTSFILE_MODE>
```
1

Item #	Boolean	Description
1	true	Dialog opens to the XML folder with ***MATB_EVENTS.xml*** as the default filename. User may pick another file with the correct format if desired. In this example, ***MATB_EVENTS-2min-TM.xml***, a file created for a specific purpose, may also be chosen. Note: The Windows default on the first use after an installation is the last folder accessed (e.g. before MATB was installed), but once you select a file from the \MATB\XML folder, this folder becomes the opening location for MATB.
2	false	The default value for this mode. ***MATB_EVENTS.xml*** is opened and read. Once the flow of events for a run have been finalized, it is recommended that the file be renamed to ***MATB_EVENTS.xml*** and this Boolean set to true.

```
<SELECT EVENTSFILE MODE>false</SELECT EVENTSFILE MODE>
```
2

A.2.4 MATB Set Run Parameters Mode

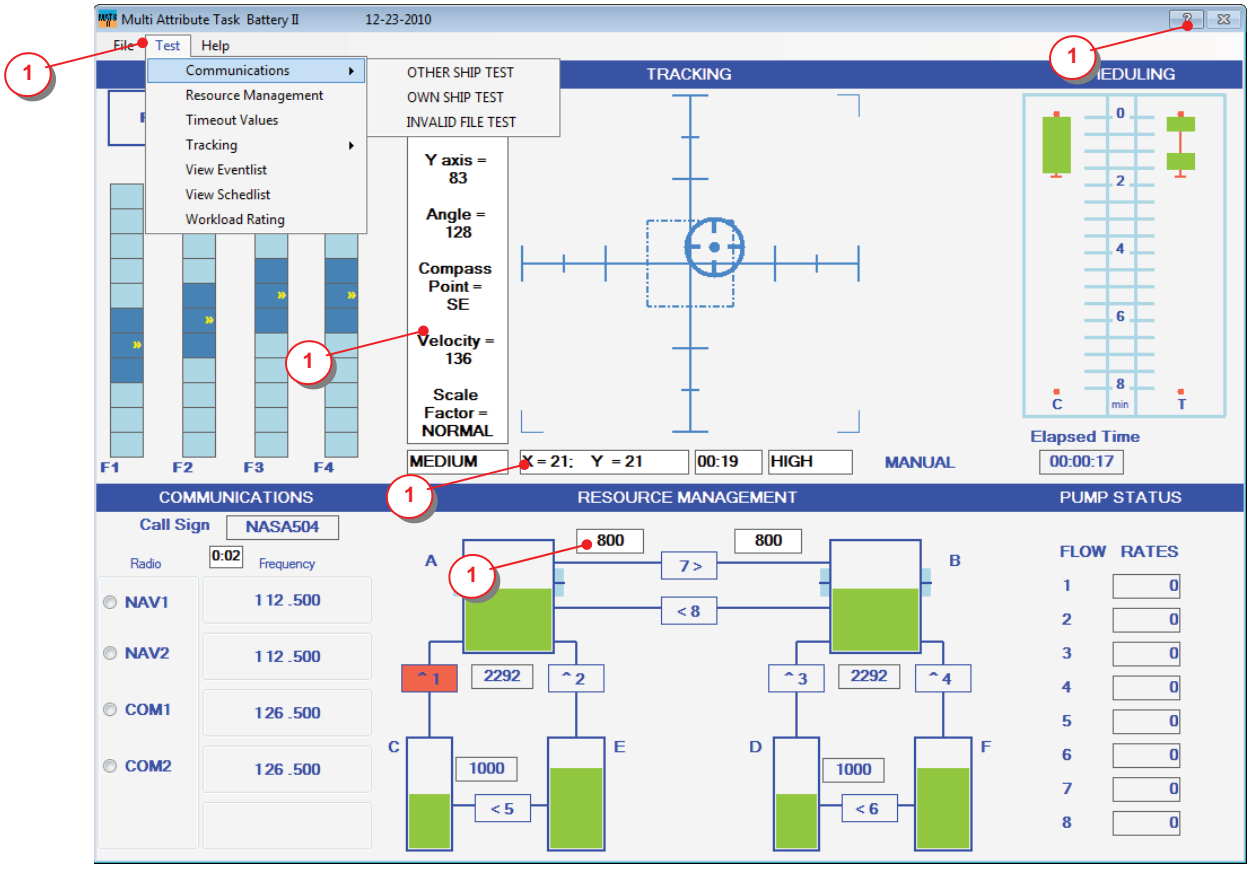



```
<SET_RUN_PARAMS_MODE>true</SET_RUN_PARAMS_MODE>
```

1

Item #	Boolean	Description
1	true	A tabbed dialog is displayed, which allows the user to change the pump flow rates, tank consumption rates, recording intervals and event timeouts read from ***MATB_CONFIG.xml***. Buttons are available to *Cancel*, *Reset All* and *Save All*. This mode is intended for use during experiment design. Once the desired values are determined and set in ***MATB_CONFIG.xml,*** this value should be changed to false.
2	false	No dialog is displayed and the values in ***MATB_CONFIG.xml*** are used. If ***MATB_CONFIG.xml*** does not contain any resource management pump and tank values, timeouts or recording intervals, the default values within MATB are used.

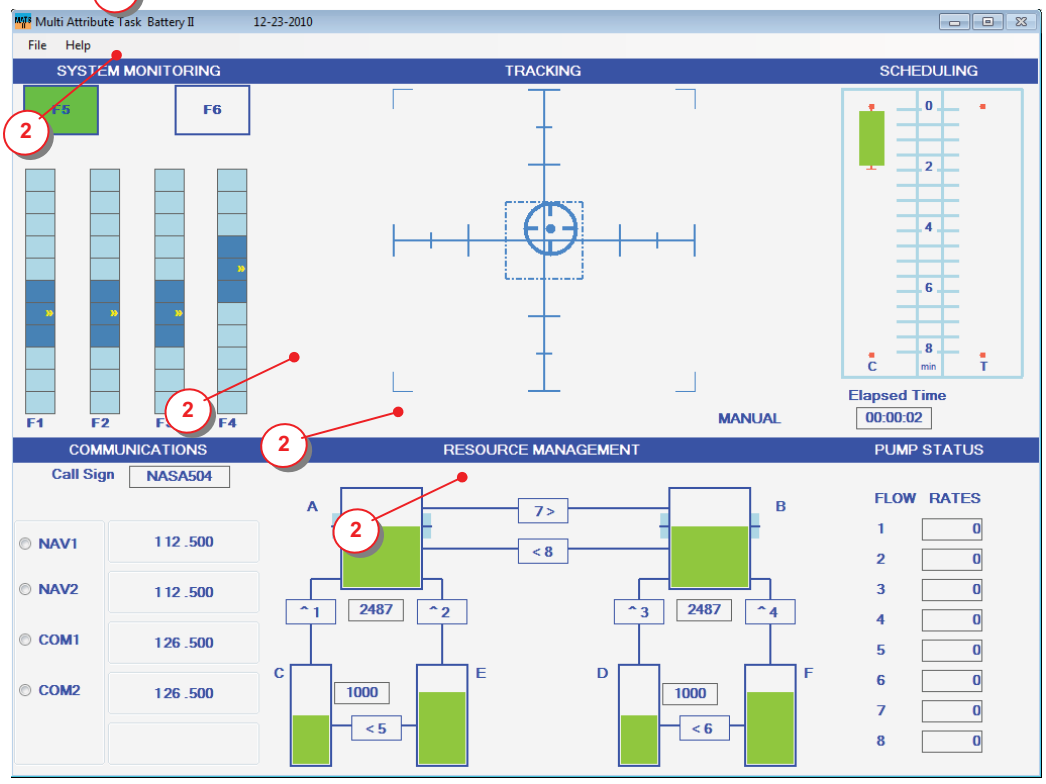
A.2.5 MATB Testing Mode



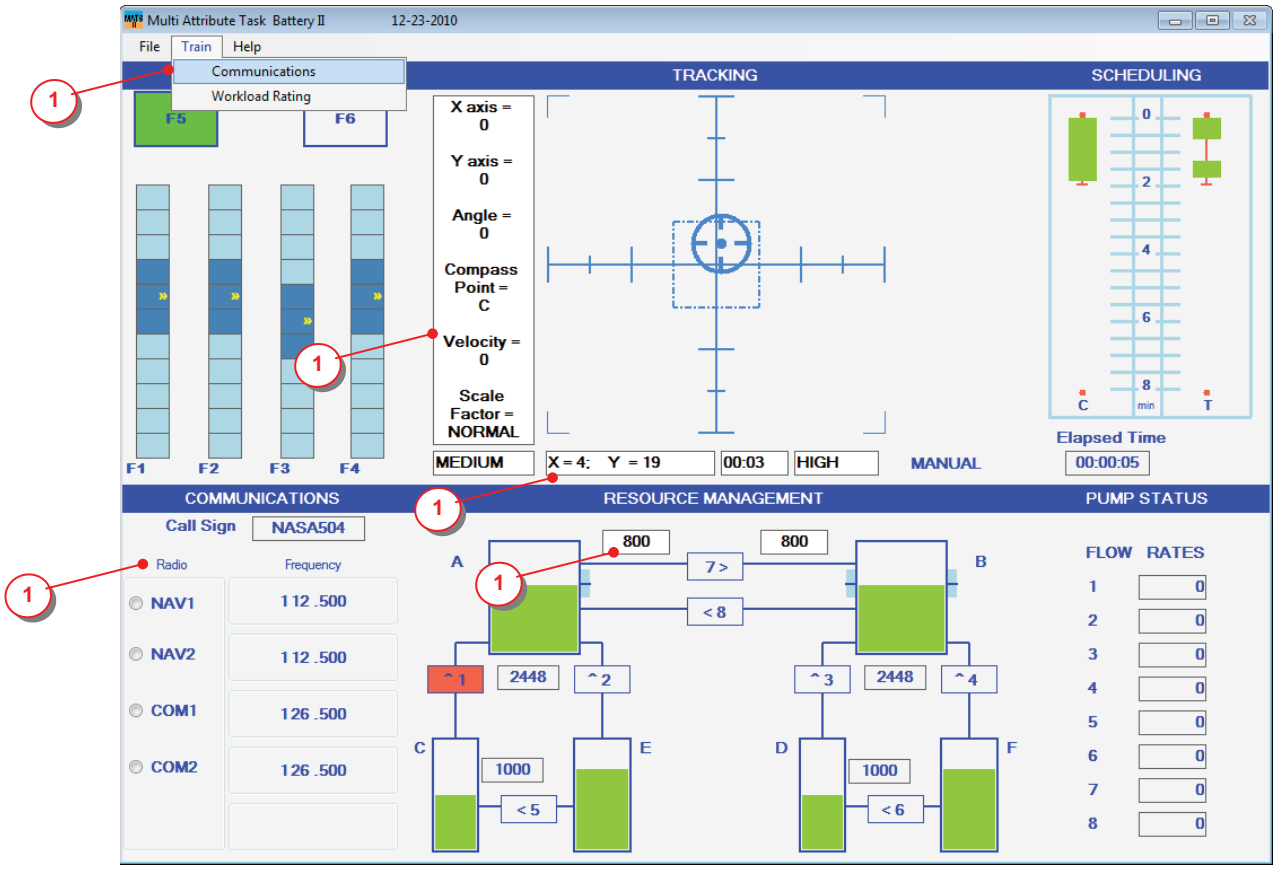

```
<TEST_MODE>true</TEST_MODE>
```

Item #	Boolean	Description
1	true	Menu item allowing selections to play sample audio files, view resource management rates, timeout values, joystick test. The user may also see a time sequenced list of the run events and scheduled communications and tracking sessions. May also activate a workload rating session. White background text boxes provide additional state data feedback. Selecting the **"?"** from the title bar launches *MATB_Documentation.chm.*
2	false	No menu item or state data feedback boxes. The **"?"** selection is only available in testing mode.

<TEST_MODE>false</TEST_MODE>



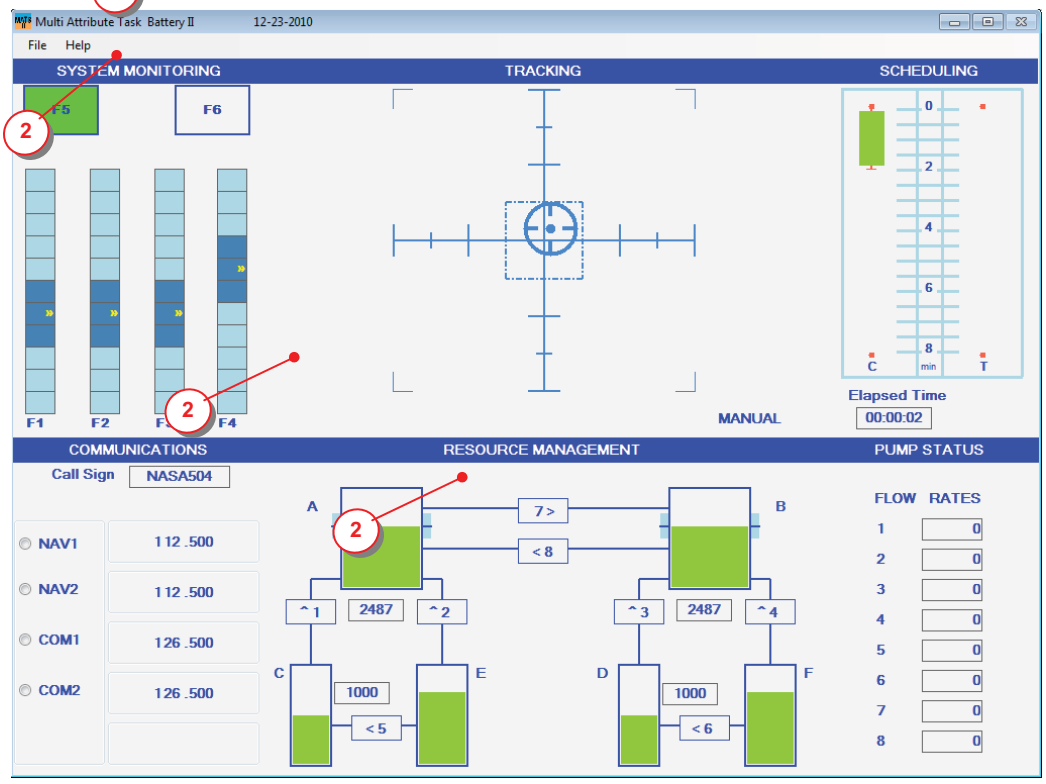
A.2.6 MATB Training Mode



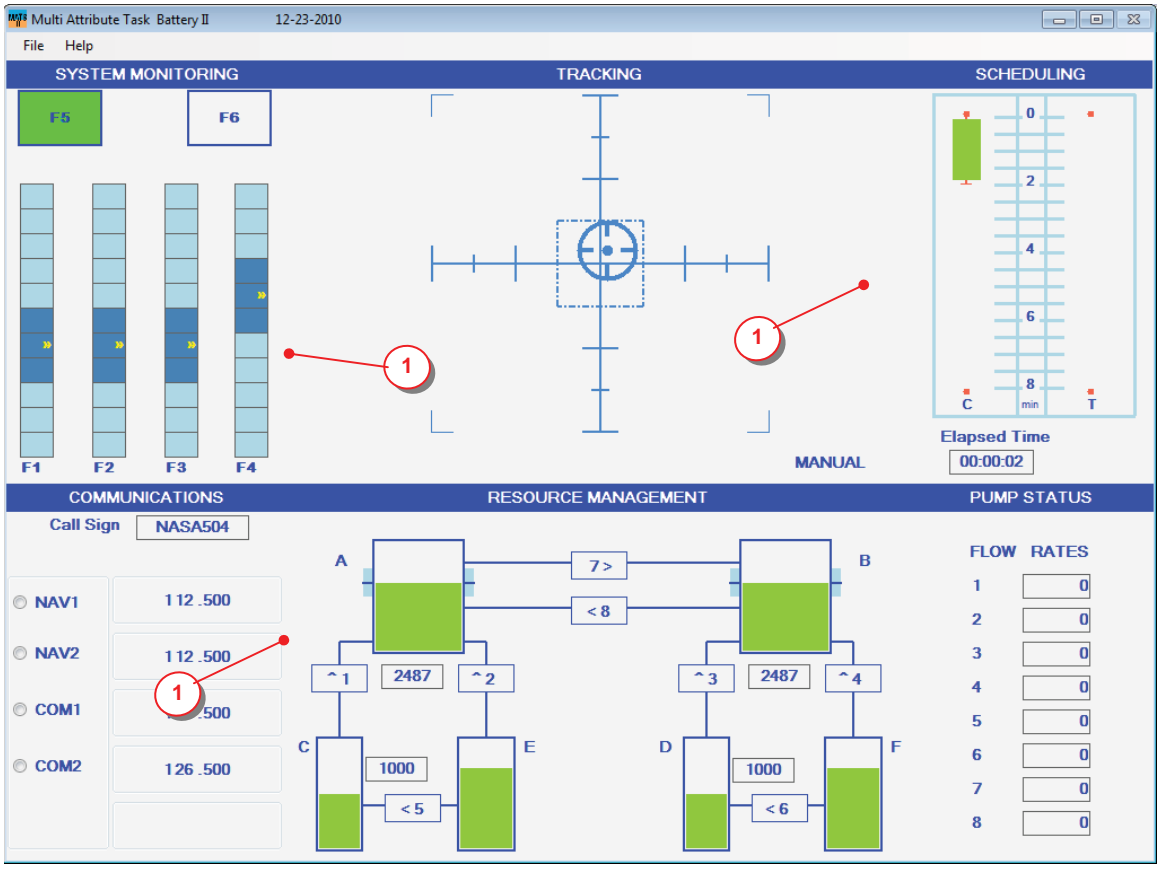

```
<TRAIN_MODE>true</TRAIN_MODE>
```

Item #	Boolean	Description
1	true	Menu item allowing selections to play sample audio files. May also activate a workload rating session. White background text boxes provide additional state data feedback. “Radio” and “Frequency” column labels are displayed on the COMM task. Tank A and B consumption rates are displayed on the RESMAN task above and to either side of the Pump 7 button controller.
2	false	No menu item or state data feedback boxes.

<TRAIN_MODE>false</TRAIN_MODE>



A.2.7 MATB Task Border Mode

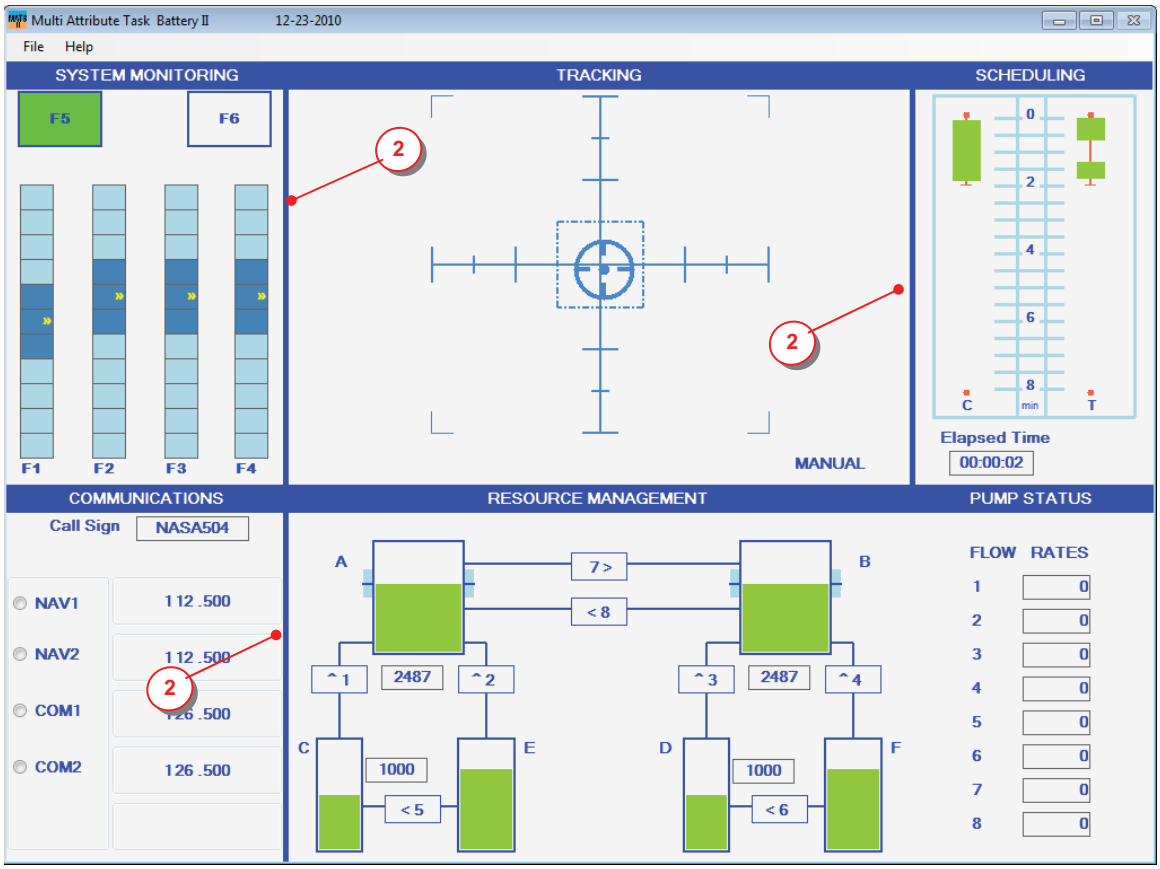



```
<TASK_BORDER_MODE>false</TASK_BORDER_MODE>
```

1

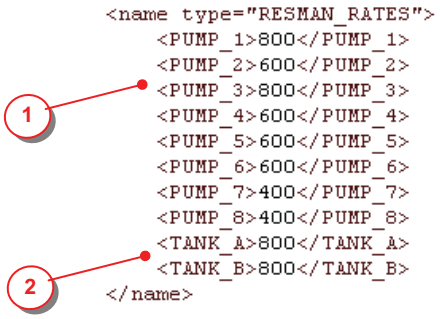
Item #	Boolean	Description
1	false	This is the default. The display has no visual dividers between the tasks.
2	true	Blue columns are displayed between the tasks

<TASK_BORDER_MODE>true</TASK_BORDER_MODE>



A.3 Resource Management Rates

MATB internally sets the following default pump flow and primary tank consumption rates in units per minute:
PUMP 1 = 800; PUMP_2 = 600; PUMP_3 = 800; PUMP_4 = 600
PUMP_5 = 600; PUMP_6 = 600 ; PUMP_7 = 400; PUMP_8 = 400
TANK_A = 800; TANK_B = 800
The user may select different rate values within the range 0-1000 units per minute through the ***MATB_CONFIG.xml***.
They may also have the opportunity to change these values through a dialog if the Set Parameters mode is true (see appendix A.2 number 4 above). These changes are only intended to be used during scenario development.

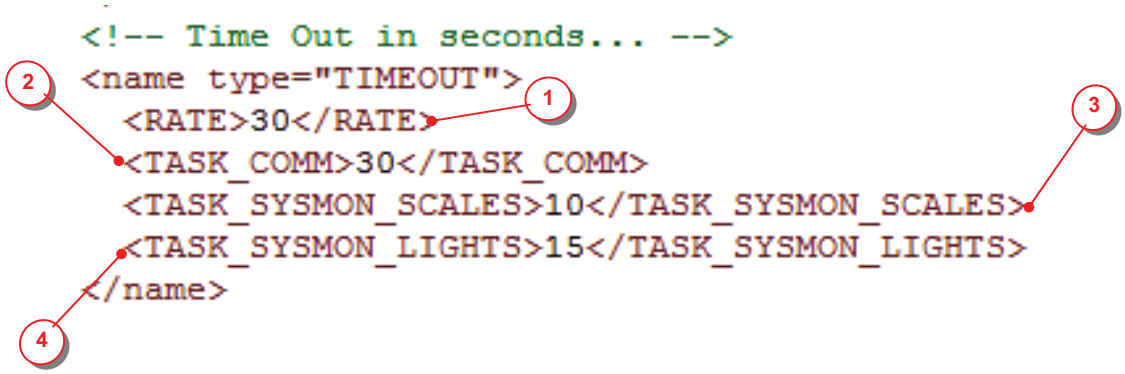



```
<name type="RESMAN_RATES">
    <PUMP_1>800</PUMP_1>
    <PUMP_2>600</PUMP_2>
    <PUMP_3>800</PUMP_3>
    <PUMP_4>600</PUMP_4>
    <PUMP_5>600</PUMP_5>
    <PUMP_6>600</PUMP_6>
    <PUMP_7>400</PUMP_7>
    <PUMP_8>400</PUMP_8>
    <TANK_A>800</TANK_A>
    <TANK_B>800</TANK_B>
</name>
```

Item #	Resource	Description
1	Pumps	The flow rate in units per minute at which a pump moves fuel from one tank to another.
2	Tanks	The volume in units per minute that the primary tanks consume (i.e. supply to the virtual engines)

A.4 Timeout Values

The subject is allowed a variable number of seconds to respond to a processed event. Specifically, the playing of a communications task sound file instructing the subject to set a radio frequency, or the subject responding to the other tasks visually changing from the normal state. The maximum allowed response time is 60 seconds. The minimum response time is 10 seconds, which is also in the default if not changed through the ***MATB_CONFIG.xml*** file or through the dialog if the Set Parameters mode is true (see appendix A.1). If a time outside the 10-60 second range is read from the ***MATB_CONFIG.xml*** file, the default value (30 seconds) is used.
Note: A timer begins as soon as the event is processed. For a COMM event, the timer may already have reached 10 seconds before the audio instruction is completed. This is the reason the COMM timeout is much longer than the SYSMON timers.



Item #	Timeout	Description
1	Rate	In this instance the subject has 30 seconds to complete the Workload Rating Questionnaire before the dialog timeouts.
2	Communications Task	The subject has 30 seconds (default) to respond to the message in the audio file. If the message is directed to a ship other than our own the instructions should be ignored and the event times out. In this case this is the correct response.
3	System Monitoring Scales	Normally a scale moves up and down randomly in the center region, but by event it either shifts to the upper or lower region. In this instance the subject is given 10 seconds to respond to the event.
4	System Monitoring Lights	Normally the Green light is on and the Red light is off. A light event toggles the state of one of the lights. In this instance the subject has 15 seconds (default) to respond by returning the light to the normal state.

A.4.1 Recording Intervals

In addition to recording event processing and subject responses, state data is periodically recorded for both the tracking and resource management tasks. State data is only recorded for the tracking task when it is in manual mode (i.e. the subject is controlling the target position with a joystick). For the tracking task, the Root Mean Square Deviation from the Center Point in Pixel Units (RMSD-C) is calculated and recorded along with the number of samples during the interval. For the resource management task the volumes of tanks A through D are recorded.

```
<!-- Recording Interval in seconds... -->
    <name type="RECORDING_INTERVAL">
      (1)<TASK_TRACK>15</TASK_TRACK>
         <TASK_RESMAN>30</TASK_RESMAN>(2)
    </name>
```

Item #	Task	Description
1	Tracking	In this instance the RMSD-C, number of samples since the last recording and the total sum of the squares of the deviation from center are recorded every 15 seconds while in manual mode.
2	Resource Management	The current tank volume will be recorded every 30 seconds in this instance

B MATB Events File

During a run, subjects respond to MATB time sequenced task state changes, known as events. The list of events is contained in an Extensible Markup Language (XML) File with the default filename of ***MATB_EVENTS.xml***. The default may be overloaded with an entry in the ***MATB_CONFIG.xml***, see appendix A.2.3. Each run starts with each task in a normal state and changes to a non-normal state when the appropriate event is triggered. The normal state for the communications (**COMM**) task is each of four radios tuned to a specified frequency. The non-normal state starts with the instructions from an audio to change the frequency on one of the four radios. The instruction may be directed to the subject (call sign "NASA 504") in which case the task is to comply, or to another aircraft in which case the instruction is ignored. The normal state for the system monitoring (**SYSMON**) task is for the Green light to be on, the Red light off, and each of the four scales to randomly move within the center region of the scale. The non-normal state is the Green light to go off, or the Red light to come on, or one of the scales to either randomly shift to the top or bottom region. The system is returned to the normal state by one of several mouse clicks or key strokes. The normal state of the tracking (**TRACK**) task is for the target (blue dot with a circle) to randomly automatically move within the inner square. In the non-normal state the subject controls the position with a joystick. The normal state for the resource management (**RESMAN**) task is for the subject to control the volume of tanks A and B with one or more of eight pumps. In the non-normal state, one or more of the pumps is broken and does not contribute to the effort. In addition to the four tasks, there is a visual indicator of the session state of the **COMM** and **TRACK** tasks. While the **SYSMON** and **RESMAN** tasks are active for the entire run once initialized, the **COMM** and **TRACK** tasks can be in either an active or inactive state. While in the inactive state no events are processed, and when they are active it is called a session. A look-ahead session bar is shown on the control panel on the upper right of the display. Active sessions are shown with a thick green bar and the normal state by a thin red line. Additionally the subject may be asked to complete a workload ratings questionnaire (**RATE**), which is also triggered by an event.

Examples of the events file entries follow.

B.1 MATB_EVENTS.xml Opening Entries

```
<MATB-EVENTS>
<!-- Start MATB Timer -->
<event startTime="0:00:00">
    <control>START</control>
</event>
<!-- Start Resource Management and System Monitoring tasks  -->
<event startTime="0:00:00">
    <sched>
      <task>RESSYS</task>
      <action>START</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
<!-- Sched task: TRACK START -->
<event startTime="0:00:02">
    <sched>
      <task>TRACK</task>
      <action>MANUAL</action>
      <update>HIGH</update>
      <response>MEDIUM</response>
   </sched>
</event>
<!-- System Monitoring - Turn Normally ON to OFF -->
<event startTime="0:00:13">
    <sysmon activity="START">
      <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
</event>
<!-- Sched task: COMM START -->
<event startTime="0:00:34">
    <sched>
      <task>COMM</task>
      <action>START</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
```

Item #	Event Type	Description
1	startTime	Every event has a ***startTime*** attribute. It is the elapsed time since the start of the run. The timer is stopped whenever the Workload Rating dialog is opened, MATB losses the focus, a Menu dialog is open, etc.
2	CONTROL	Starts the run and turns on the elapsed time counter.
3	SCHED	Both the RESMAN and SYSMON tasks are started by the keyword **RESSYS**. Both tasks remain active for the entire run.
4	SCHED	Starts a manual TRACK task. The target position is updated by MATB at the high rate, while the joystick response to the subjects input is at the medium rate.
5	SYSMON	Turns OFF the normally ON Green light.
6	SCHED	Starts a COMM task session at a run elapsed time of 0 hours, 0 minutes and 34 seconds.

B.2 MATB_EVENTS.xml Closing Entries

```
<!-- Sched task: TRACK STOP -->
<event startTime="0:04:00">
    <sched >
      <task>TRACK</task>
      <action>AUTO</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
<!-- System Monitoring - Turn Normally ON to OFF -->
<event startTime="0:04:13">
    <sysmon>
      <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
</event>
<!-- System Monitoring - Turn Normally OFF to ON -->
<event startTime="0:04:33">
    <sysmon>
      <monitoringLightType>RED</monitoringLightType>
   </sysmon>
</event>
<event startTime="0:04:40">
    <sched >
      <task>COMM</task>
      <action>STOP</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
<!-- Stop MATB Timer and end experiment -->
<event startTime="0:05:00">
    <control>END</control>
</event>
</MATB-EVENTS>
```

Item #	Event Type	Description
1	SCHED	Stops MANUAL tracking, and returns the TRACK task to the automatic or normal state
2	SYSMON	Changes light state, in this case the GREEN light which is normally ON, turns OFF, or the RED light is turned ON.
3	SCHED	Ends a COMM session.
4	CONTROL	Ends the run

B.3 COMM State Change Entries

```
<!-- Own ship radio change -->
<event startTime="0:01:20">
    <comm>
      <ship>OWN</ship>
      <radio>COM1</radio>
      <freq>131.050</freq>
   </comm>
</event>
```

```
<!-- Other ship radio change -->
<event startTime="0:01:55">
    <comm>
      <ship>OTHER</ship>
      <radio>NAV2</radio>
      <freq>112.550</freq>
   </comm>
</event>
```

Item #	COMM Event Type	Description
1	OWN	At a run elapsed time of one minute and twenty seconds an audio file instructing ***NASA 504*** to change the COM1 radio to frequency 131.050 is played. The subject should comply.
2	OTHER	At a run elapsed time of one minute and fifty five seconds an audio file instructing an aircraft with some other call sign to change the NAV2 radio to frequency 112.550 is played. Since the subject only responds to instructions for ***NASA 504***, this instruction should be ignored.

B.4 RESMAN State Change Entries

```
<!-- Sched task: RESMAN fail pump 2  -->
<event startTime="0:00:05">
    <resman>
      <fail>P2</fail>
  </resman>
</event>
```


```
<!-- Sched task: RESMAN fix pump 1  -->
<event startTime="0:02:05">
    <resman>
      <fix>P1</fix>
  </resman>
</event>
```

Item #	RESMAN Event Type	Description
1	fail	At a run elapsed time of no minutes and five seconds pump two is failed. If the subject previously turned pump two on, it will be turned off. Any attempts to turn pump two on while it is failed will not succeed. The color of pump two will change to red.
2	fix	At a run elapsed time of two minutes and five seconds pump one is fixed. The color of the pump changes to gray. If the subject turns pump two on, it will begin pumping and the color turns green.

B.5 SYSMON State Change Entries

```
<!-- Start System Monitoring and Turn Normally ON to OFF -->
<event startTime="0:00:05">
    <sysmon>
      <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
</event>
<!-- Start System Monitoring and Turn Normally ON to OFF -->
<event startTime="0:00:15">
    <sysmon>
      <monitoringLightType>RED</monitoringLightType>
   </sysmon>
</event>
<!-- System Monitoring - Move SCALE ONE UP -->
<event startTime="0:00:23">
  <sysmon>
      <monitoringScaleNumber>ONE</monitoringScaleNumber>
      <monitoringScaleDirection>UP</monitoringScaleDirection>
   </sysmon>
</event>
<event startTime="0:01:13">
    <sysmon>
      <monitoringScaleNumber>TWO</monitoringScaleNumber>
      <monitoringScaleDirection>DOWN</monitoringScaleDirection>
   </sysmon>
</event>
```

Item #	SYSMON Event Type	Description
1	GREEN	The **GREEN** light, which is normally ON, turns OFF
2	RED	The **RED** light, which is normally OFF, turns ON
3	ONE UP	The random cycling of scale ONE shifts from the central range to the top range
4	TWO DOWN	The random cycling of scale TWO shifts from the central range to the bottom range

B.6 TRACK State Change Entries

```
<!-- Sched task: TRACK START -->
<event startTime="0:02:00">
    <sched>
      <task>TRACK</task>
      <action>MANUAL</action>
      <update>MEDIUM</update>
      <response>MEDIUM</response>
   </sched>
</event>
```

1

```
<!-- Sched task: TRACK STOP -->
<event startTime="0:05:55">
    <sched >
      <task>TRACK</task>
      <action>AUTO</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
```

2

Item #	SCHED Event Type	Description
1	TRACK MANUAL	Starts a manual tracking session. In manual mode the subject uses the joystick to keep the target within the inner grid.
2	TRACK AUTO	Ends a manual tracking session. The joystick is not polled for inputs and the target is automatically caged within the inner grid.

B.7 RATE State Change Entry

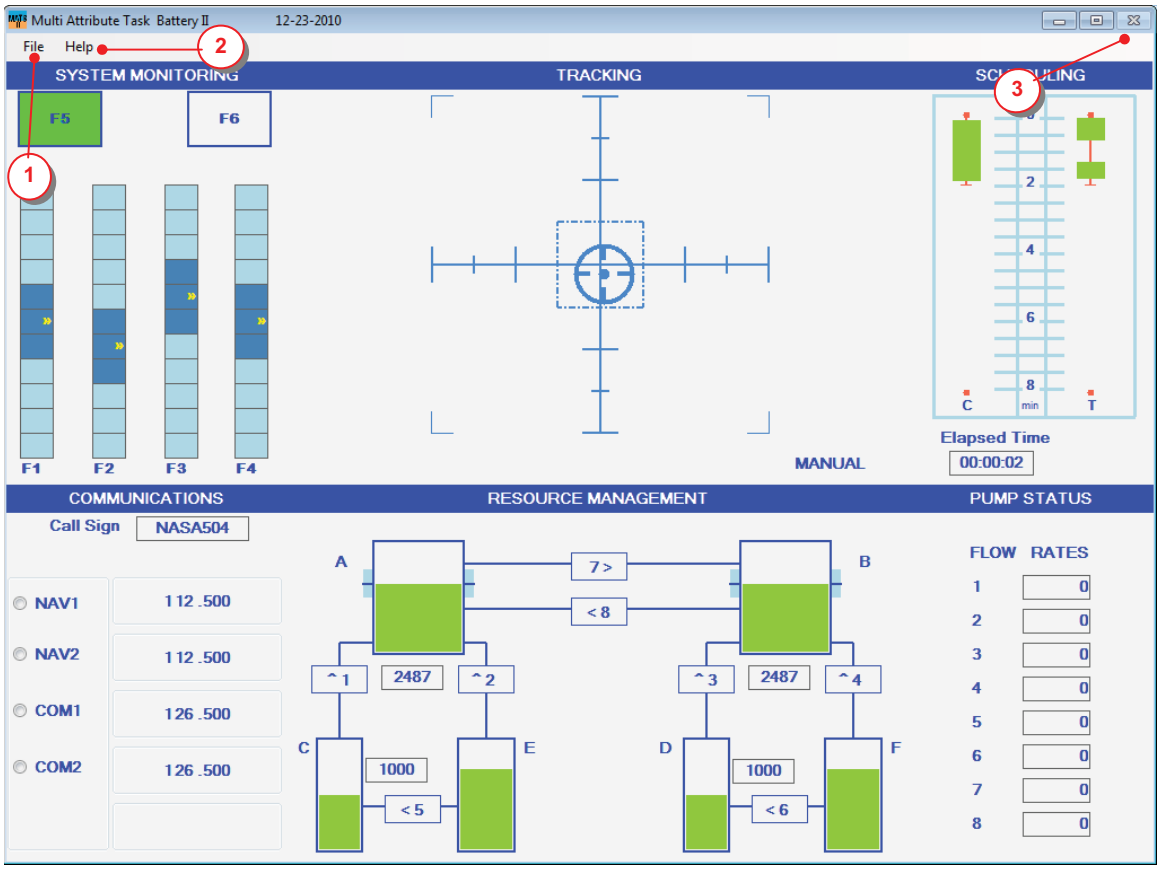
```
<!-- Workload Rating -->
<event startTime="0:02:30">
    <rate>START</rate>
</event>
```

Item #	RATE Event Type	Description
1	START	The Workload Rating Scale questionnaire appears at a time of two minutes and thirty seconds. While the questionnaire is opened the elapsed timer is not updated. The questionnaire will timeout if the subject does not complete the scales in the specified time.

C MATB Menu Operations

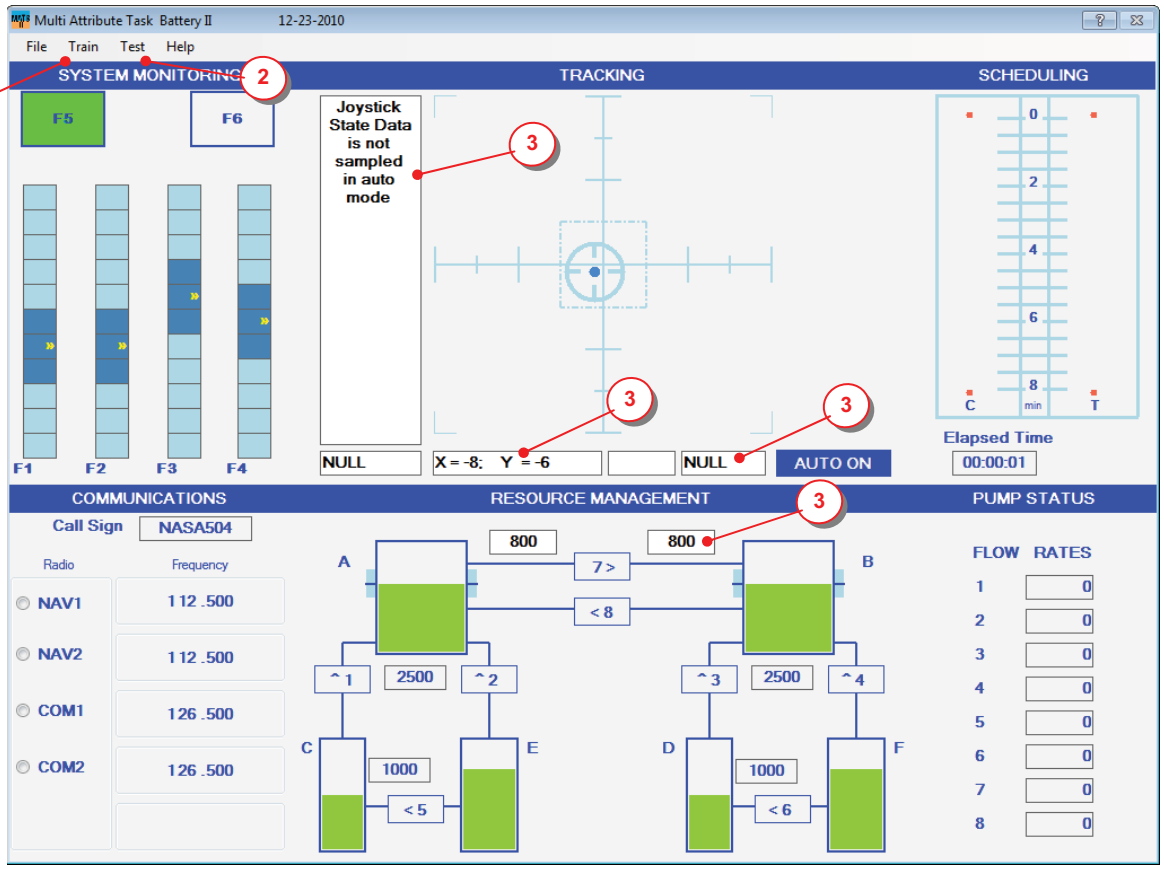
Menus allow the user to make a selection to perform some action with MATB. The ***File*** and ***Help*** selections are always available, while the ***Train*** and ***Test*** selections are only available if the appropriate mode is set to *true* in ***MATB_CONFIG.xml*** file.

C.1 File & Help Menu Items



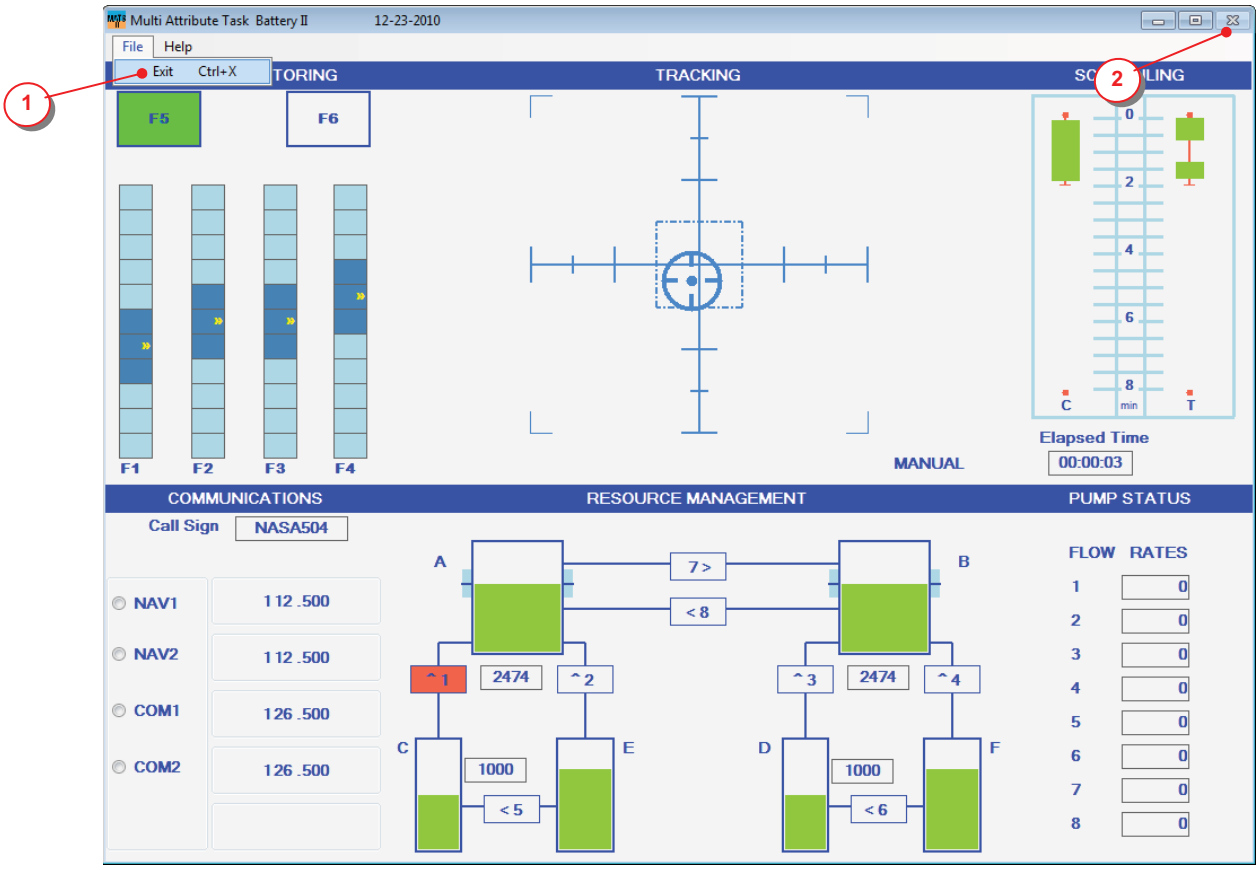
Item #	Menu Item	Description
1	File	The available actions are dynamic based upon the mode and phase of operations
2	Help	Two static choices which display dialogs with information about MATB
3	X	Note that the Close(X) button in the title bar is disabled. MATB may not be ended by this method familiar to PC users. See Appendix C.3 for more information.

C.2 File, Train, Test & Help Menu Items



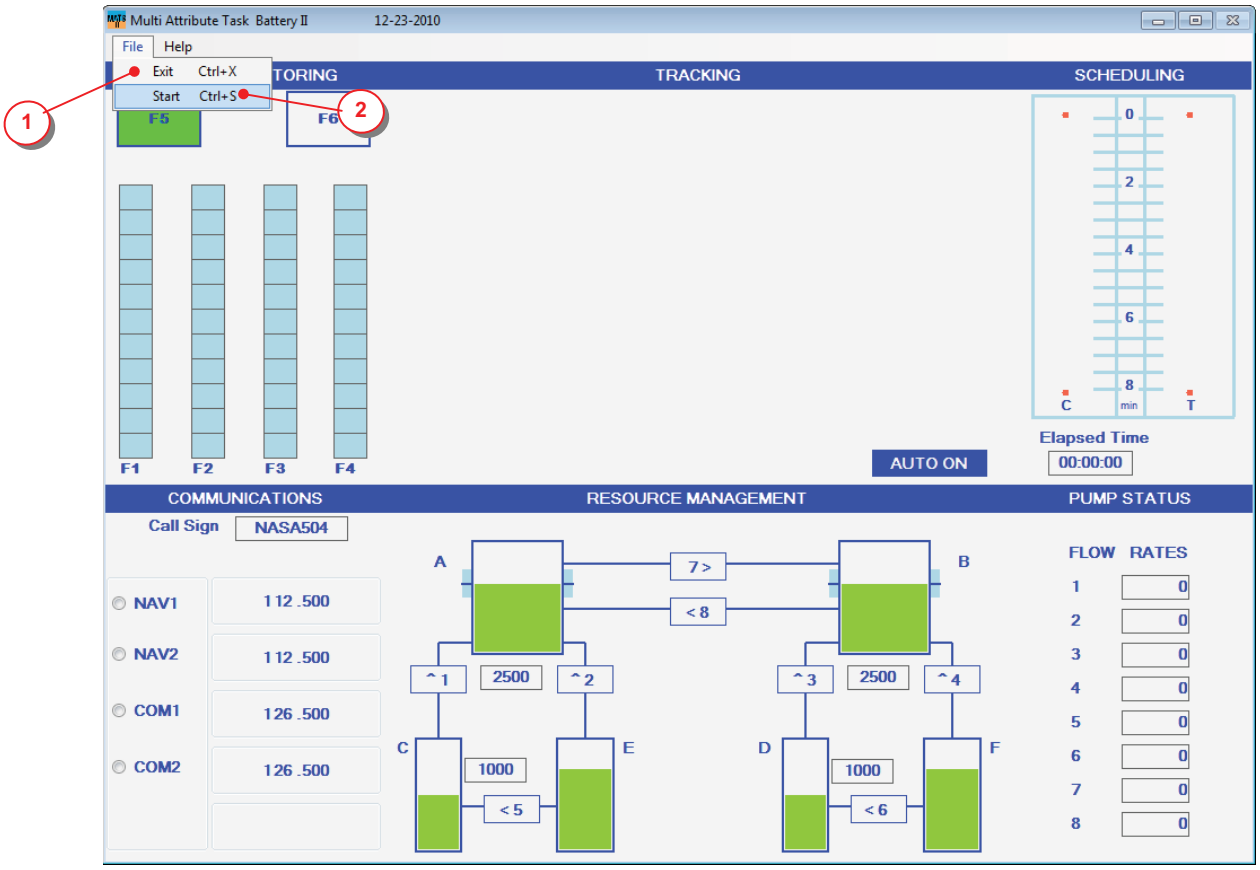
Item #	Menu Item	Description
1	Test	Menu is available only when **Test** mode set to *true* in MATB_CONFIG.xml
2	Train	Menu is available only when **Train** mode set to *true* in MATB_CONFIG.xml
3		When either **Test** or **Train** mode set to *true* in MATB_CONFIG.xml additional state data is displayed on the main form. It is always shown with a black foreground on a white background.

C.3 File -> Exit Menu Item



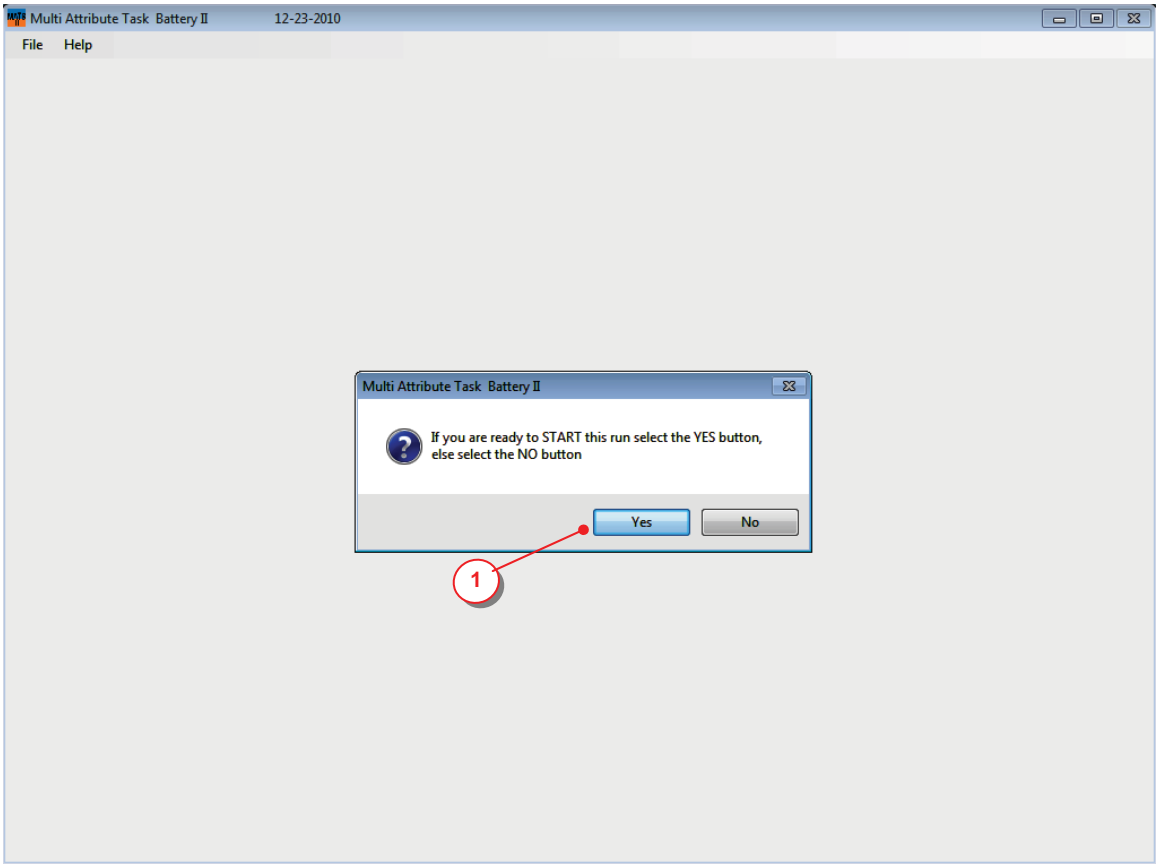
Item #	Menu Item	Description
1	Exit	Terminates MATB. Shortcut key is ***Ctrl+X***
2	X	Note that the Close(X) button in the title bar is disabled. MATB may not be ended by this method familiar to PC users. This eliminates the chance of a single key stroke / mouse click error ending a run prematurely.

C.4 File -> Start Menu Item



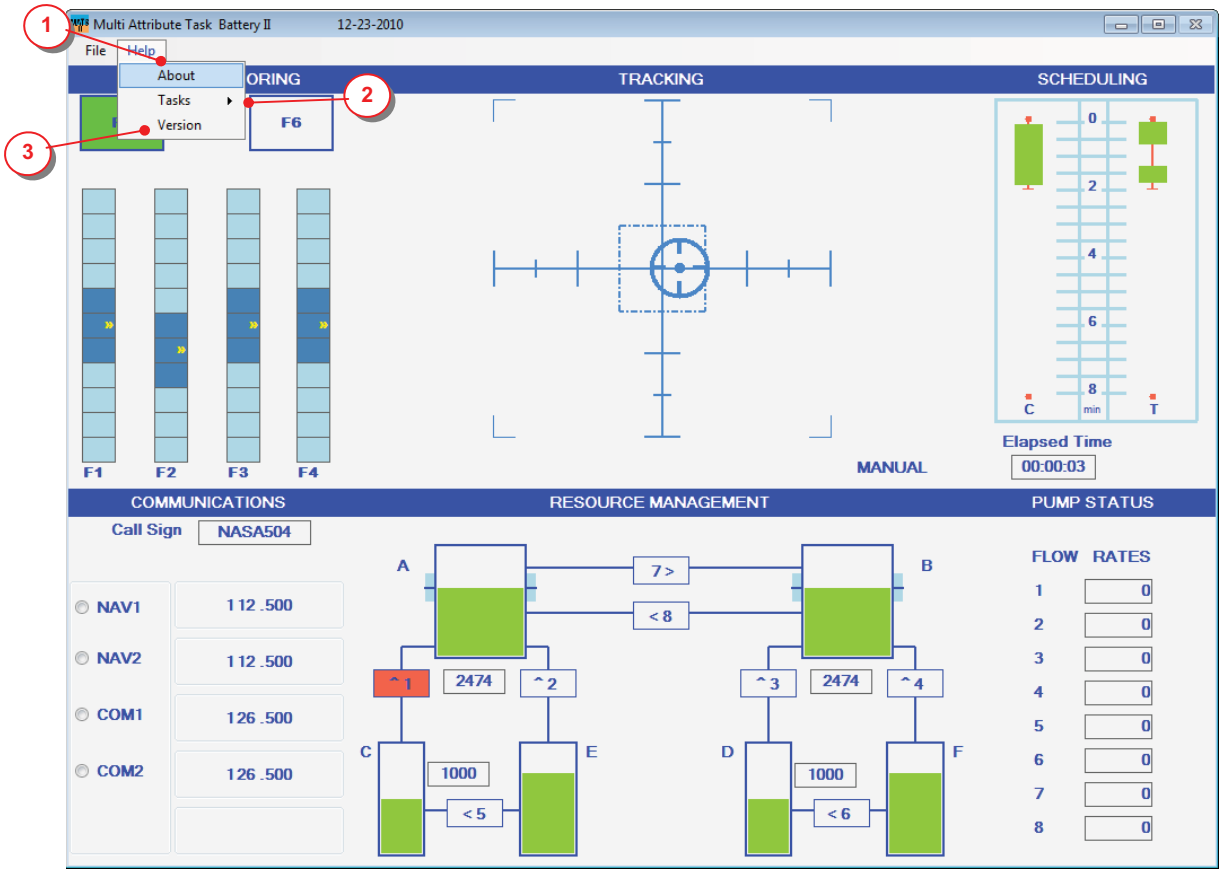
Item #	Menu Item	Description
1	Exit	Terminates MATB. Shortcut key is ***Ctrl+X***.
2	Start	First step to start MATB, if Auto Start mode *is* ***false*** in ***MATB_CONFIG.xml***. If Auto Start mode is set to ***true*** then this menu selection is not available and once the Events file is read, the events start to be processed. During subject training it may be useful not to use Auto Start. The shortcut key to start the run is ***Ctrl+S.***

C.5 File -> Start Dialog



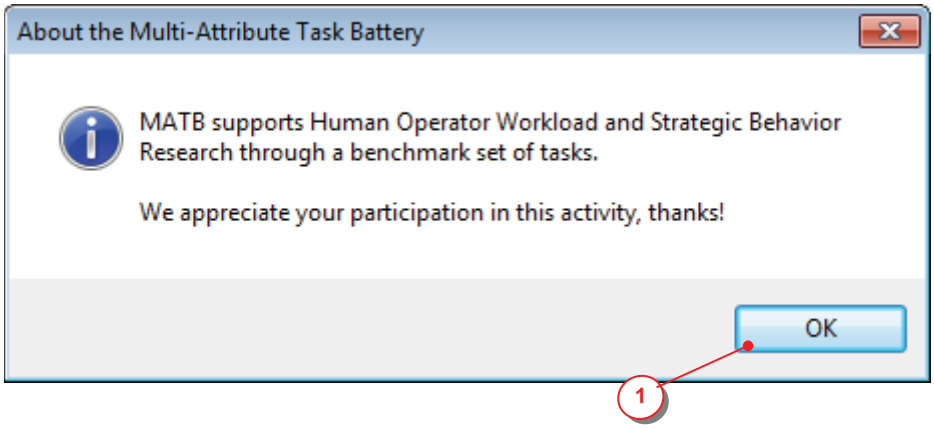
Item #	Dialog Box	Description
1	Start	***Yes*** starts MATB, while ***No*** closes the dialog.

C.6 Help Menu Items



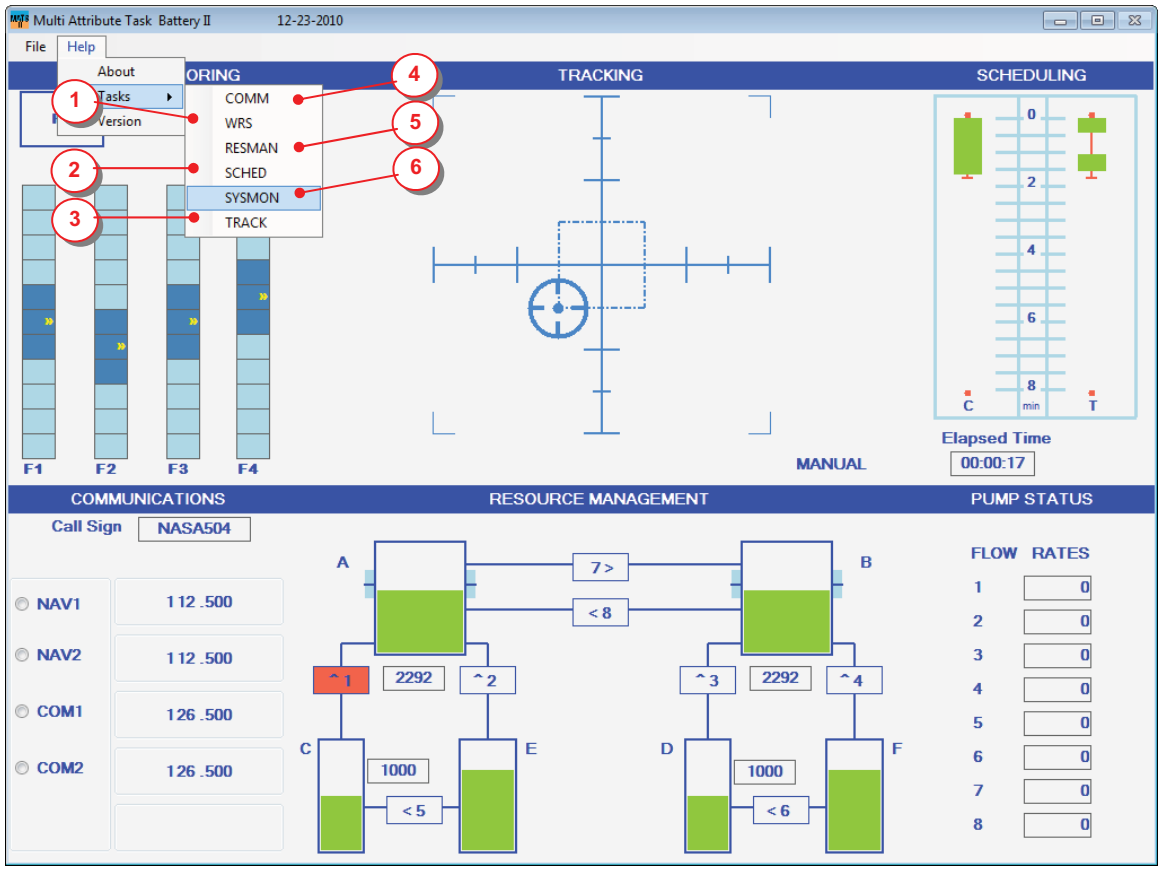
Item #	Menu Item	Description
1	About	Launches dialog with short statement about MATB
2	Tasks	Opens submenus to select from a set of "in a Nutshell" dialog
3	Version	Launches dialog with version information

C.7 Help -> About Dialog



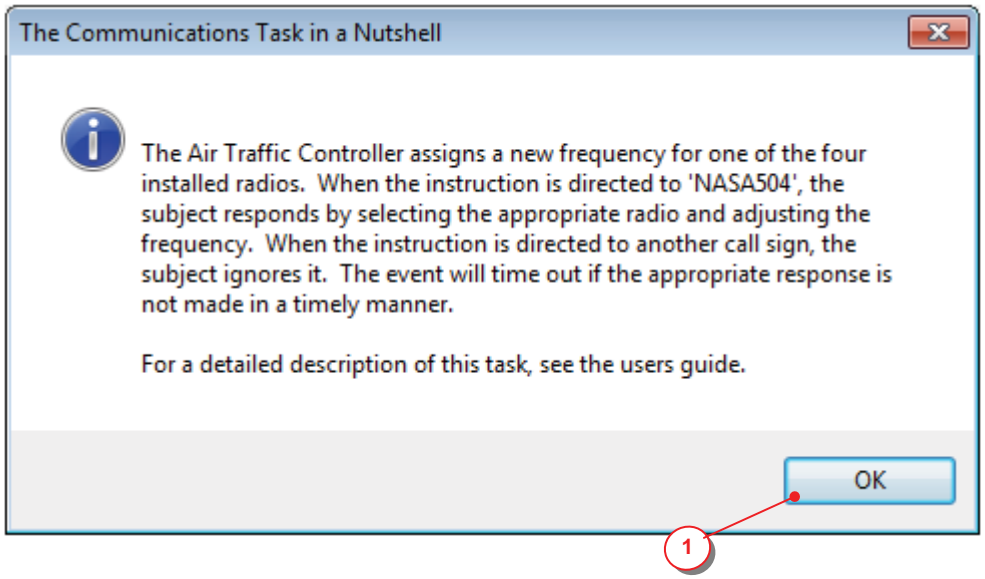
Item #	Dialog Box	Description
1	OK	A short statement to acknowledge the subjects role in MATB. Select ***OK*** to close the message box.

C.8 Help -> Tasks Menu Items



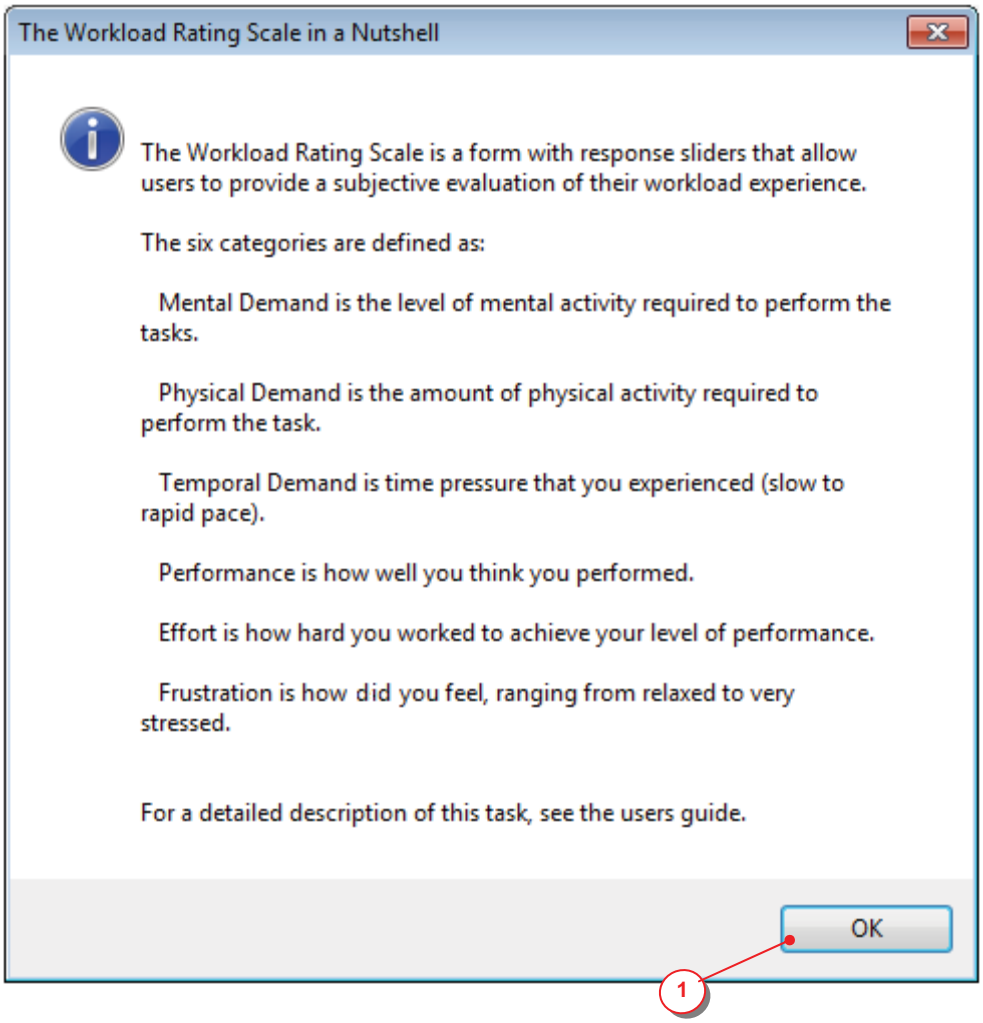
Item #	Menu Item	Description
1	WRS	Launches the Workload Rating Scale "in a Nutshell" dialog
2	SCHED	Launches the Scheduling "in a Nutshell" dialog
3	TRACK	Launches the Tracking task "in a Nutshell" dialog
4	COMM	Launches the Communications task "in a Nutshell" dialog
5	RESMAN	Launches the Resource Management task "in a Nutshell" dialog
6	SYSMON	Launches the System Management task "in a Nutshell" dialog

C.9 Help -> Tasks -> COMM Dialog



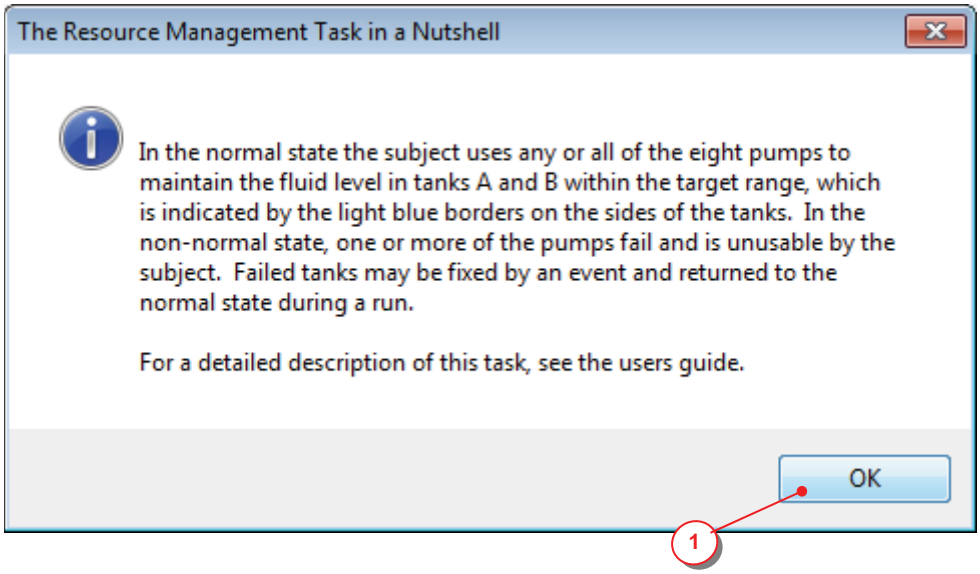
Item #	Dialog Box	Description
1	OK	A short description of the communications task. Select ***OK*** to close the message box.

C.10 Help -> Tasks -> WRS Dialog



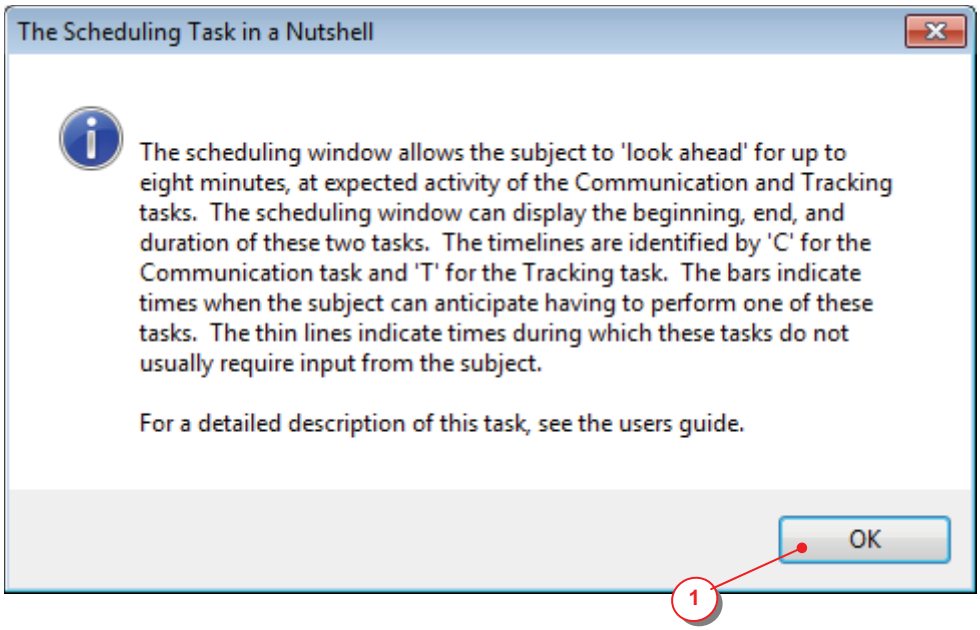
Item #	Dialog Box	Description
1	OK	A short description of the Workload Rating Scale. Select ***OK*** to close the message box.

C.11 Help -> Tasks -> RESMAN Dialog



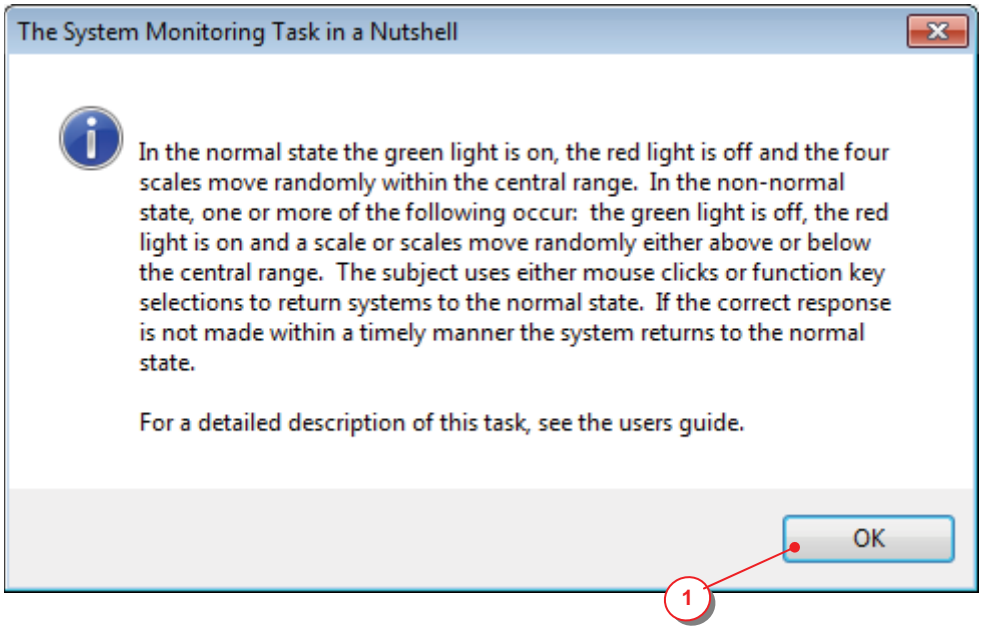
Item #	Dialog Box	Description
1	OK	A short description of the resource management task. Select ***OK*** to close the message box.

C.12 Help -> Tasks -> SCHED Dialog



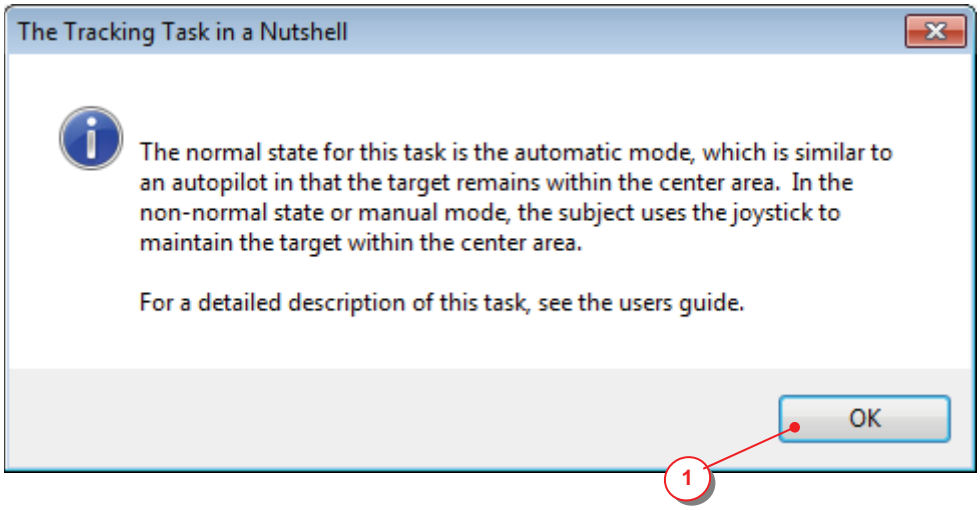
Item #	Dialog Box	Description
1	OK	A short description of the scheduling look ahead. Select ***OK*** to close the message box.

C.13 Help -> Tasks -> SYSMON Dialog



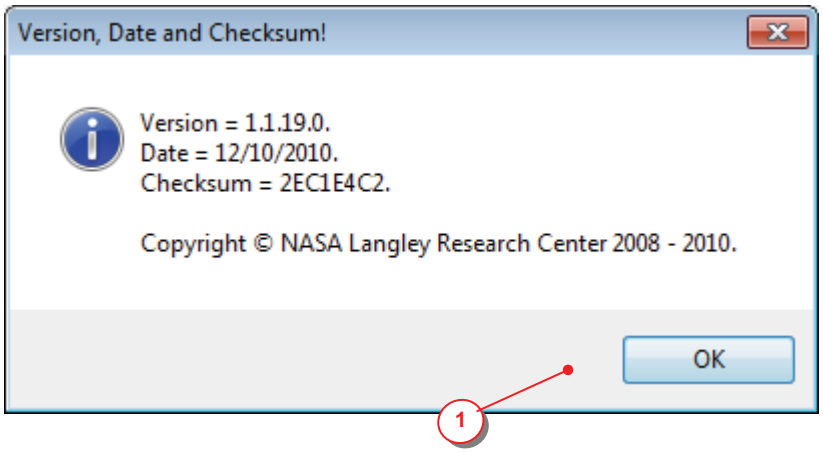
Item #	Dialog Box	Description
1	OK	A short description of the system monitoring task. Select ***OK*** to close the message box.

C.14 Help -> Tasks -> TRACK Dialog



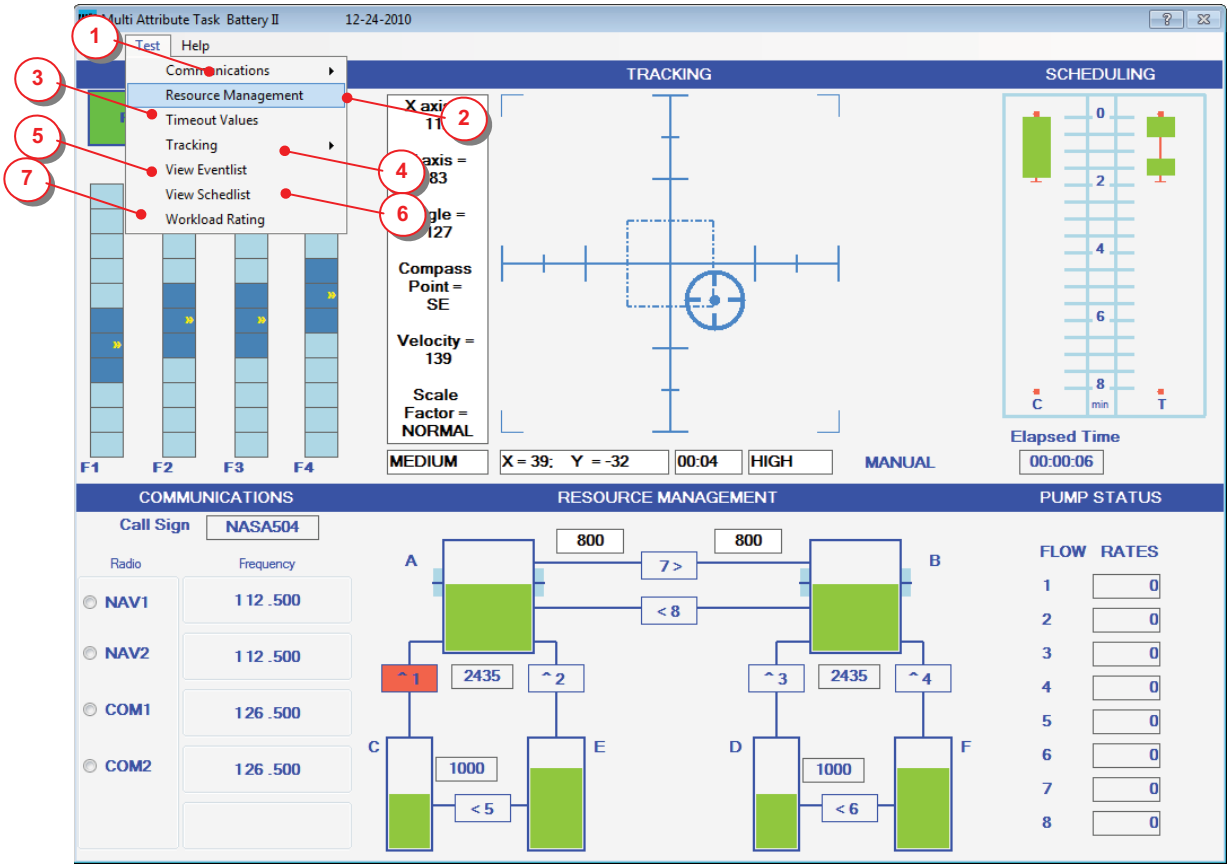
Item #	Dialog Box	Description
1	OK	A short description of the tracking task. Select ***OK*** to close the message box.

C.15 Help -> Version Dialog



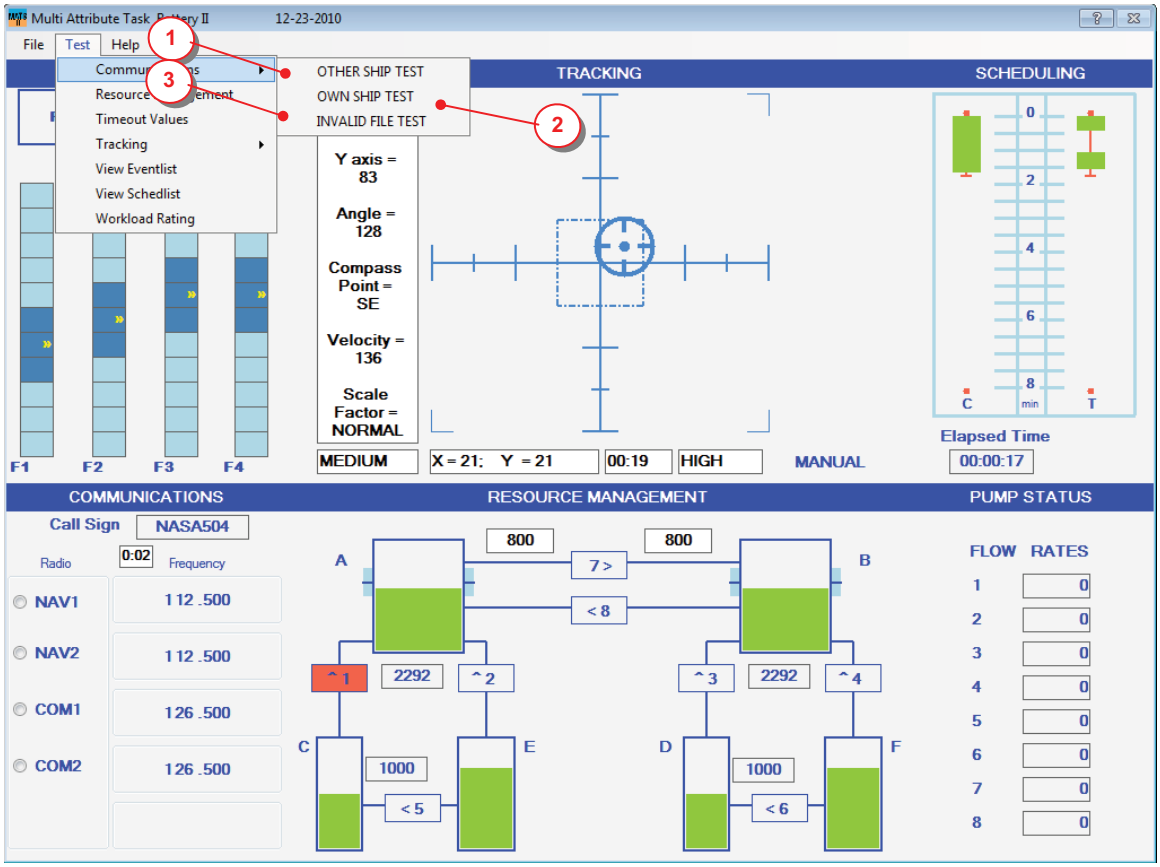
Item #	Dialog Box	Description
1	OK	Displays version number and date along the checksum of the build version. This is important because audio, configuration and events files may be unique to a specific version. Additionally new features will be added to MATB over time. Select ***OK*** to close the message box.

C.16 Test -> All Menu Items



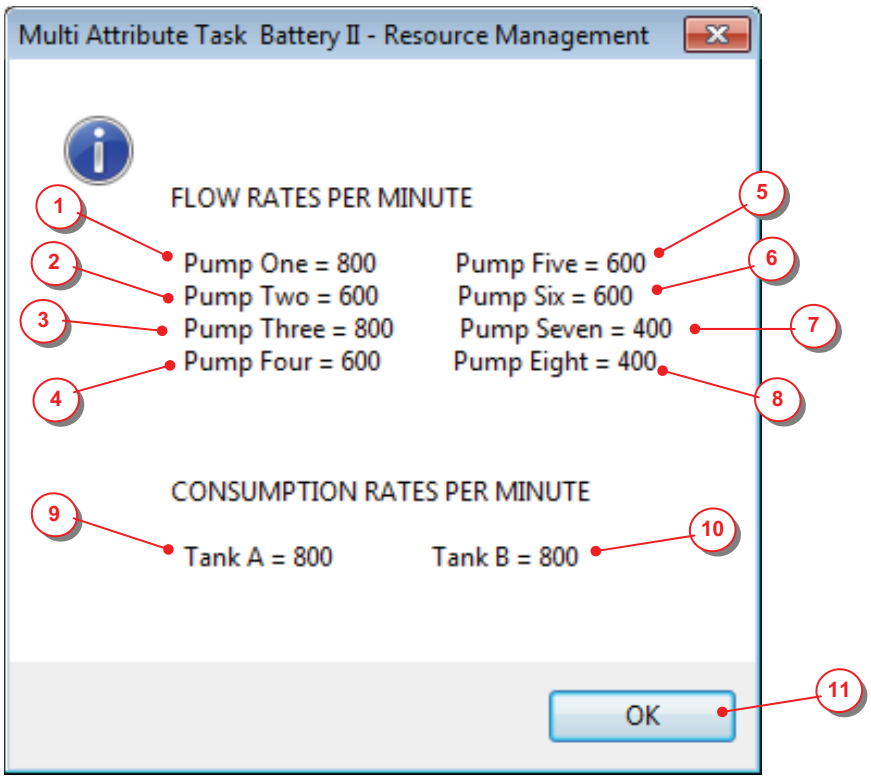
Item #	Menu Item	Description
1	Communication	Displays the dialog used to play sample audio files. Tests that the MATB audio files may be used on the computer
2	Resource Management	Displays the dialog listing the pump flow and tank consumption rates used for the current run.
3	Timeout Values	Displays dialog listing the event timeout values in seconds used for the current run.
4	Tracking	Displays the dialog that shows the state of the attached joystick.
5	View Eventlist	Displays the list view of the time sequenced events loaded for the run.
6	View Schedlist	Displays the list views of the time sequenced communications and manual tracking sessions loaded for the run.
7	Workload Rating	Displays the Workload Rating Scale form, which can then be completed.

C.17 Test -> Communications Menu Items



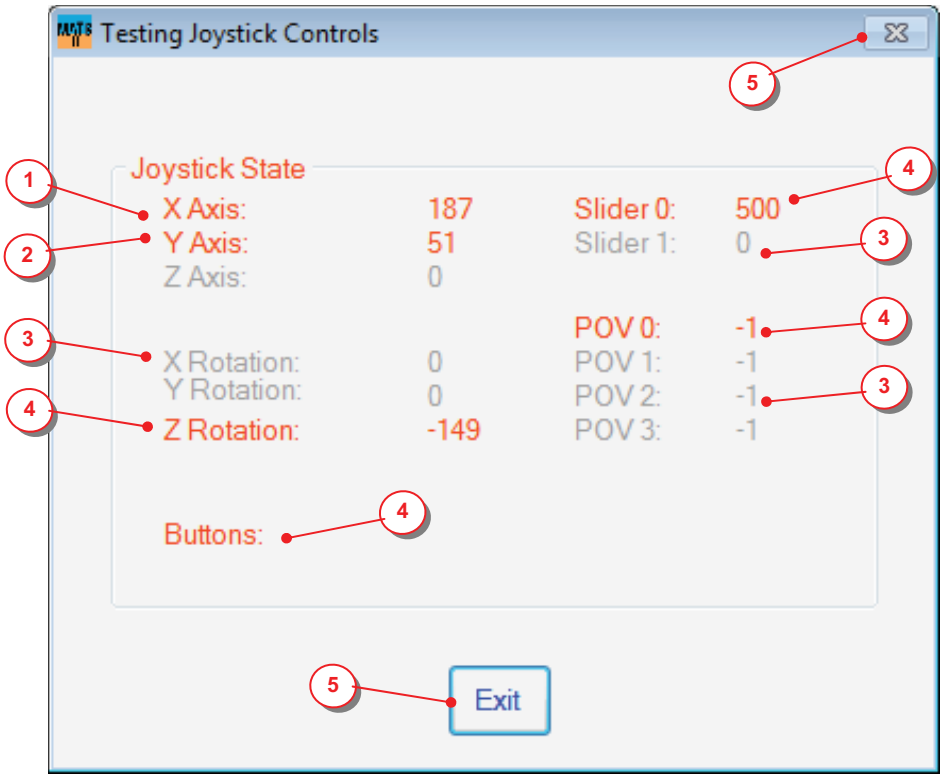
Item #	Item	Description
1	Other Ship	Plays an audio file instructing an aircraft with a call sign other than ***NASA 504*** to tune one of the four radios to a specific frequency. The subject ignores these instructions during actual runs.
2	Own Ship	Plays an audio file instructing ***NASA 504*** to tune one of the four radios to a specific frequency. The subject would respond to this instruction during an actual run.
3	Invalid File Test	Trying to play an audio file not found in the Audio sub-folder displays a dialog to that effect. If properly constructed and tested, this dialog would be displayed during an actual run.

C.18 Test -> Resource Management Dialog



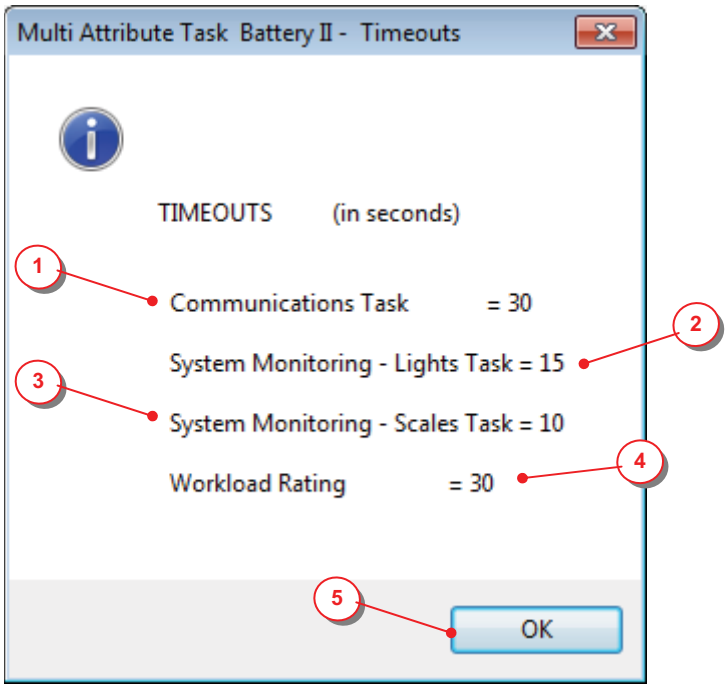
Item #	Item	Description
1	Pump One	Flow rate in units per minute when the pump is on and operational
2	Pump Two	Flow rate in units per minute when the pump is on and operational
3	Pump Three	Flow rate in units per minute when the pump is on and operational
4	Pump Four	Flow rate in units per minute when the pump is on and operational
5	Pump Five	Flow rate in units per minute when the pump is on and operational
6	Pump Six	Flow rate in units per minute when the pump is on and operational
7	Pump Seven	Flow rate in units per minute when the pump is on and operational
8	Pump Eight	Flow rate in units per minute when the pump is on and operational
9	Tank A	Consumption rate in units per minute provided the tank is not empty
10	Tank B	Consumption rate in units per minute provided the tank is not empty
11	OK	Close the dialog when finished by selecting the ***OK*** button.

C.19 Test -> Tracking Dialog



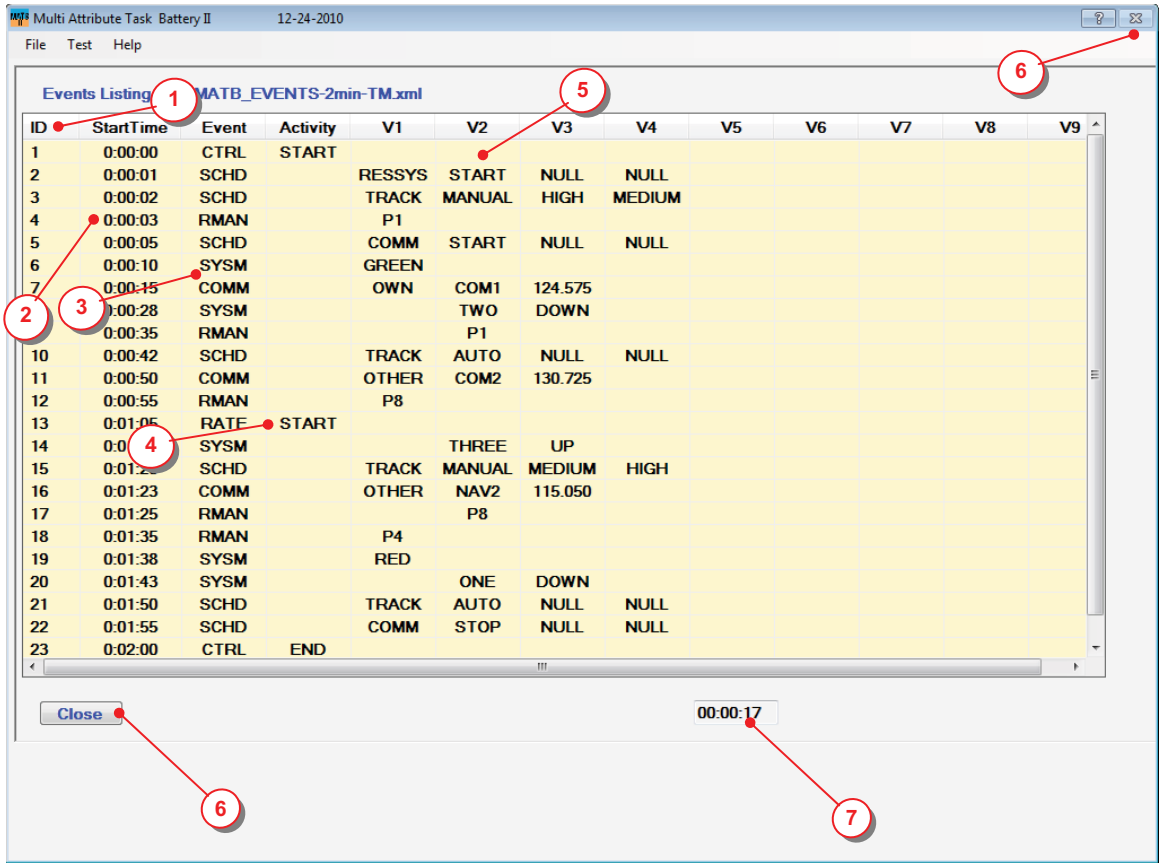
Item #	Item	Description
1	X Axis	A red foreground means the attached joystick is sending this signal to the computer. X & Y axis state data are the only inputs we read and only in manual mode.
2	Y Axis	A red foreground means the attached joystick is sending this signal to the computer. X & Y axis state data are the only inputs we read and only in manual mode.
3	Multiple	A gray foreground means the attached joystick is not sending this signal to the computer. MATB does not use this state data.
4	Multiple	A red foreground means the attached joystick is sending this signal to the computer. MATB does not use this state data.
5	Exit	Note that the Close(X) button in title bar is disabled in the Training mode. The dialog is closed with the ***Exit*** button.

C.20 Test -> Timeouts Dialog



Item #	Item	Description
1	Communications Task	Timeout value is seconds. If the subject does not respond to the audio message within this time period, it is recorded and controls become unresponsive to input.
2	System Monitoring - Lights	Timeout value is seconds. If the subject does not respond to the change in light color within this time period, it is recorded. Note lights and scales may have different timeout values.
3	System Monitoring - Scales	Timeout value is seconds. If the subject does not respond to the change in a scale movement within this time period, it is recorded. Note lights and scales may have different timeout values.
4	Workload Rating	Timeout value is seconds. If the subject does not complete and enter responses to the workload rating scale within this time period, it is recorded and the dialog closed.
5	OK	Closes the dialog when finished by selecting the ***OK*** button.

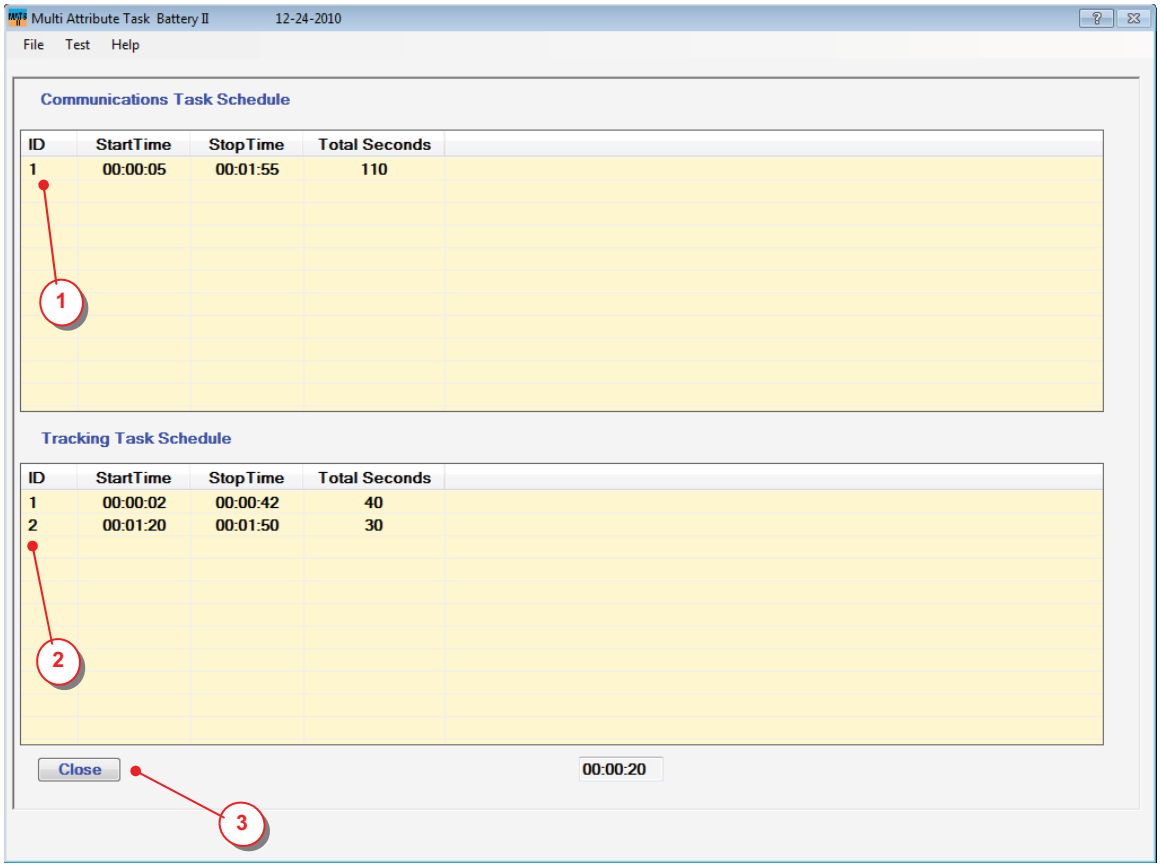
C.21 Test -> View Events List



ID	StartTime	Event	Activity	V1	V2	V3	V4	V5	V6	V7	V8	V9
1	0:00:00	CTRL	START									
2	0:00:01	SCHD		RESSYS	START	NULL	NULL					
3	0:00:02	SCHD		TRACK	MANUAL	HIGH	MEDIUM					
4	0:00:03	RMAN		P1								
5	0:00:05	SCHD		COMM	START	NULL	NULL					
6	0:00:10	SYSM		GREEN								
7	0:00:15	COMM		OWN	COM1	124.575						
8	0:00:28	SYSM			TWO	DOWN						
9	0:00:35	RMAN			P1							
10	0:00:42	SCHD		TRACK	AUTO	NULL	NULL					
11	0:00:50	COMM		OTHER	COM2	130.725						
12	0:00:55	RMAN			P8							
13	0:01:05	RATE	START									
14	0:0	SYSM			THREE	UP						
15	0:01:2	SCHD		TRACK	MANUAL	MEDIUM	HIGH					
16	0:01:23	COMM		OTHER	NAV2	115.050						
17	0:01:25	RMAN			P8							
18	0:01:35	RMAN			P4							
19	0:01:38	SYSM			RED							
20	0:01:43	SYSM			ONE	DOWN						
21	0:01:50	SCHD		TRACK	AUTO	NULL	NULL					
22	0:01:55	SCHD		COMM	STOP	NULL	NULL					
23	0:02:00	CTRL	END									

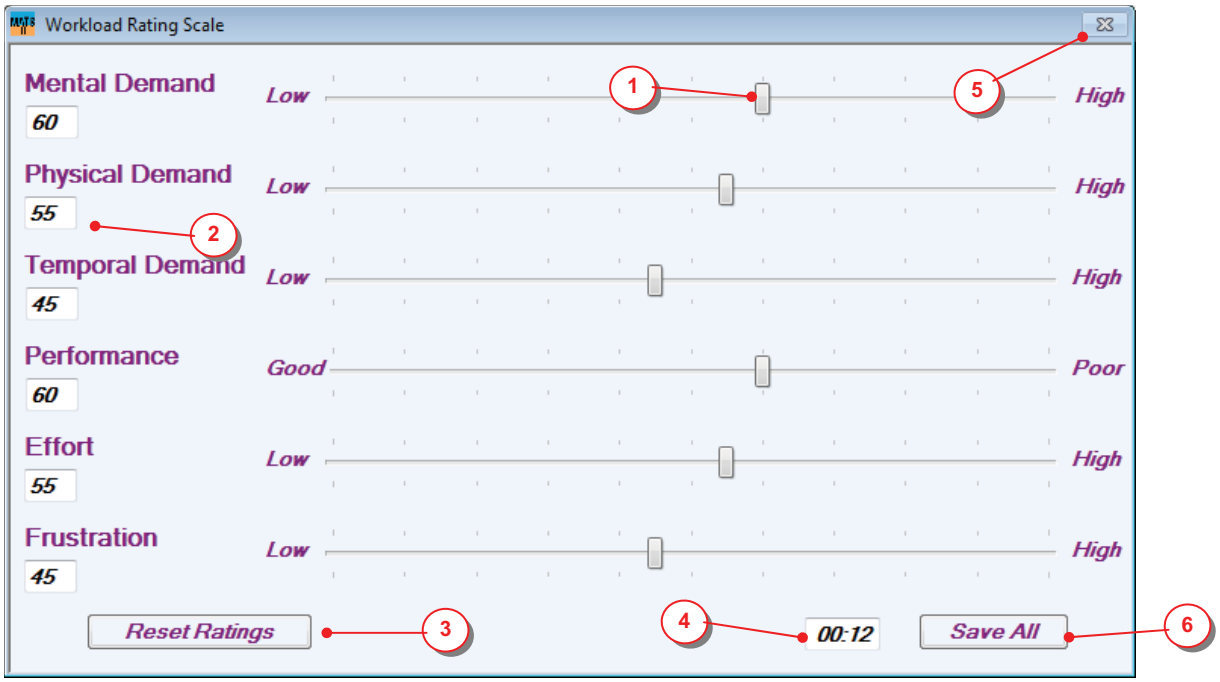
Item #	Item	Description
1	ID	Sequence number of this event.
2	Start Time	The start time of the event with respect to the run start time. The run timers may be paused, so event start time may not be in sync with clock time.
3	Event Type	Events may be COMM, CTRL, RESMAN, SCHED, SYSMON, TRACK or workload RATE. CTRL are control events, the others are tasks, task scheduling or workload rating questionnaire.
4	Activity	Start, Stop or End.
5	Attribute	Attribute type.
6	Close	Note that the ***Close(X)*** button in title bar is disabled in the Test mode. The dialog is closed with the ***Close*** button.
7	Time	The run elapsed time when the list is displayed. The runs stop while the event list is displayed.

C.22 Test -> View Schedule List



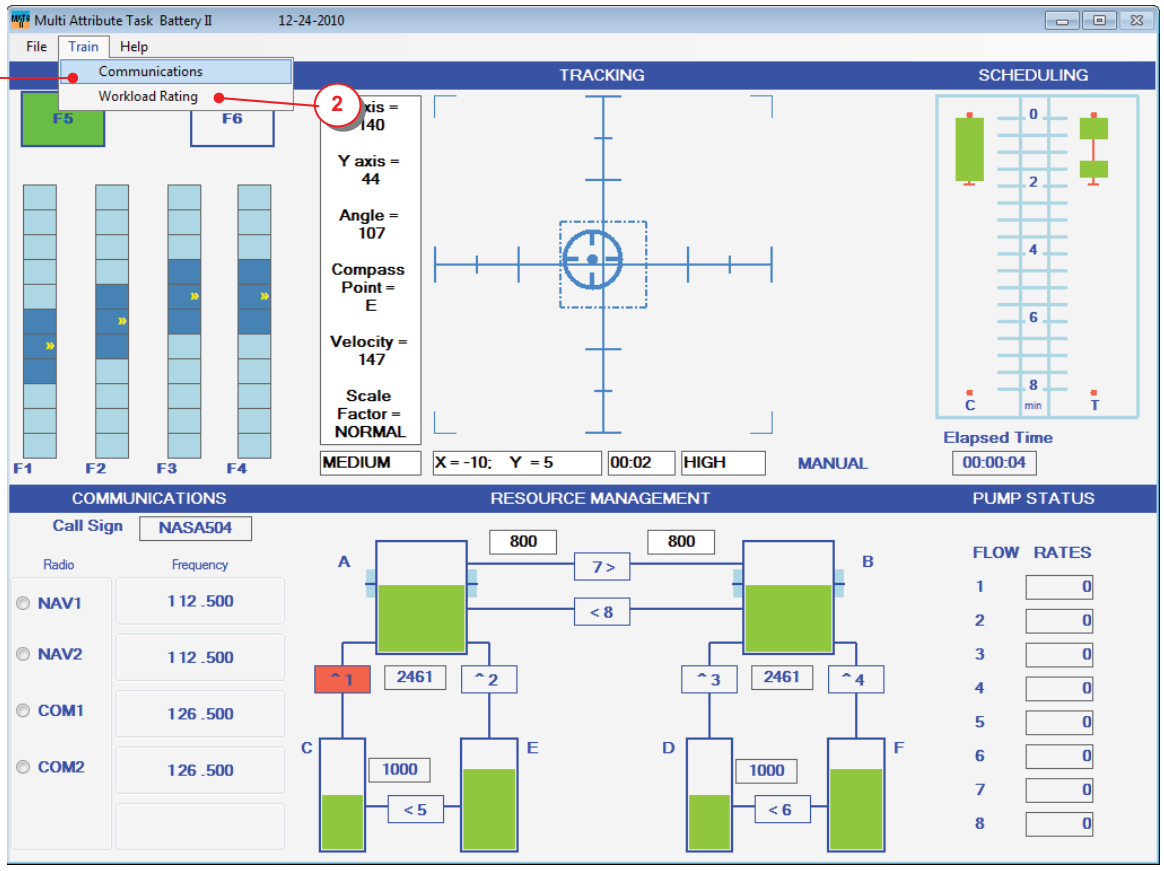
Item #	Item	Description
1	Communications	Start and stop times of each session along with the duration of the session. Extracted from the events file.
2	Tracking	Start and stop times of each session along with the duration of the session. Extracted from the events file.
3	Close	Note that the ***Close(X)*** button in the title bar is disabled in the Test mode. The dialog is closed with the ***Close*** button

C.23 Test -> Workload Rating Scale



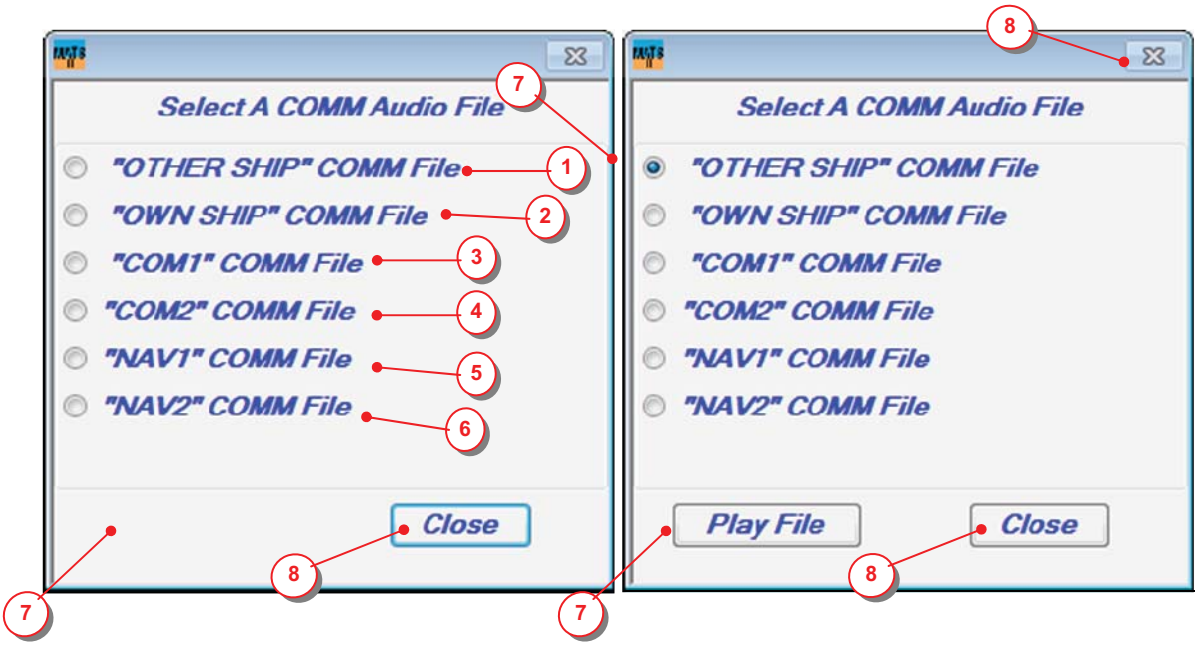
Item #	Item	Description
1	Slider	The value is selected by moving the slider to the desired position
2	Value	The actual value is shown with black foreground and a white background in Test Mode. It is not displayed in the normal mode.
3	Reset	The subject may reset all values to the initial conditions if desired
4	Elapsed Time	The number of seconds the subject has used in completing the questionnaire. Time is not displayed in normal mode.
5	X	Note that the ***Close(X)*** button in the title bar is disabled in the Test mode.
6	Save All	The results are recorded and the dialog closed with the ***Save All*** button

C.24 Train Menu Items



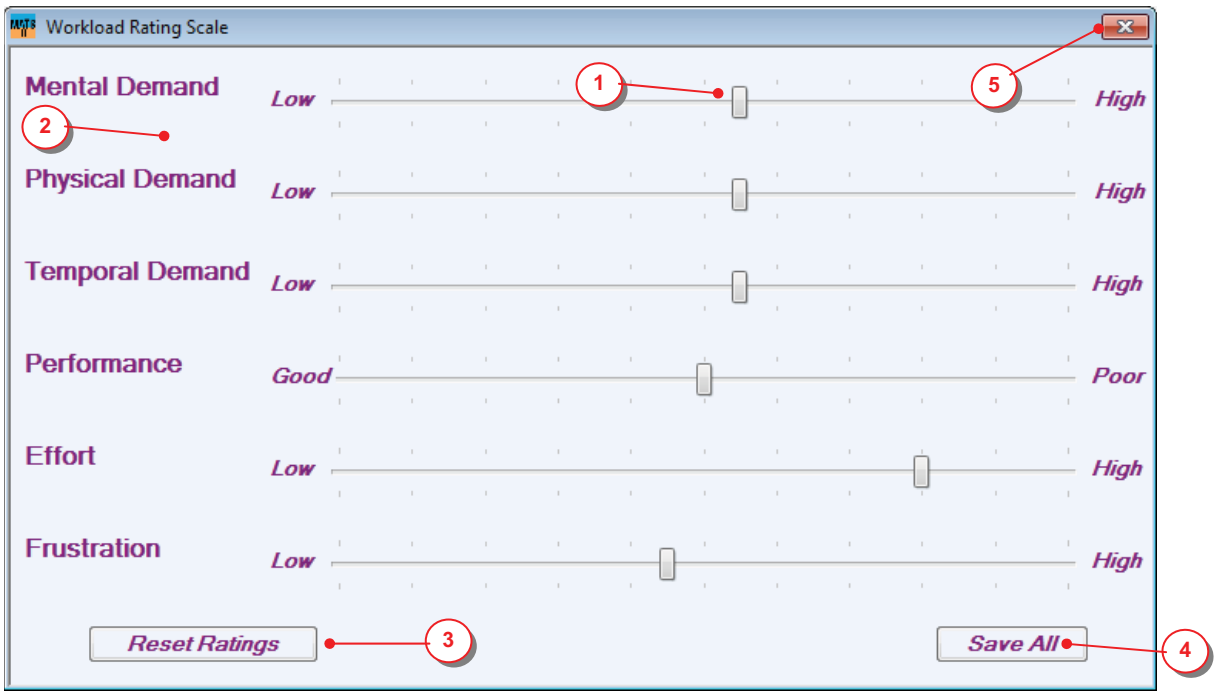
Item #	Menu Item	Description
1	Communication	Displays the dialog used to play sample audio files. Allows the subject to hear how each type of file sounds
2	Workload Rating	Displays the Workload Rating questionnaire, which can then be completed.

C.25 Train -> Communications Dialog



Item #	Menu Item	Description
1	Other Ship	Selects an audio file instructing an aircraft with a call sign other than ***NASA 504*** to tune one of the four radios to a specific frequency. The subject ignores these instructions during actual runs. File *OTHER_TESTFILE.wav* must be in the MATB Audio subfolder.
2	Own Ship	Selects an audio file instructing *NASA 504* to tune one of the four radios to a specific frequency. The subject would respond to this instruction during an actual run. File *OWN_TESTFILE.wav* must be in the MATB Audio subfolder.
3	COM One	Selects an audio file instructing the subject to tune the communications one radio to a specific frequency. File *COM1_TESTFILE.wav* must be in the MATB Audio subfolder.
4	COM Two	Selects an audio file instructing the subject to tune the communications two radio to a specific frequency. File *COM2_TESTFILE.wav* must be in the MATB Audio subfolder.
5	NAV One	Selects an audio file instructing the subject to tune the navigation one radio to a specific frequency. File *NAV1_TESTFILE.wav* must be in the MATB Audio subfolder.
6	NAV Two	Selects an audio file instructing the subject to tune the navigation two radio to a specific frequency. File *NAV2_TESTFILE.wav* must be in the MATB Audio subfolder.
7	Play File	Note that the ***Play File*** button is not always visible. Once an option is selected via a radio button, it becomes visible as shown on the right.
8	Close	Note that the ***Close(X)*** button in title bar is disabled in the Training mode. The dialog is closed with the ***Close*** button

C.26 Train -> Workload Rating



Item #	Item	Description
1	Slider	The value is selected by moving the slider to the desired position.
2	Value	The actual value is not displayed in Training Mode, as it is in Test Mode. It is not displayed in the normal mode.
3	Reset	The subject may reset all values to the initial conditions, if desired.
4	Save All	The ***Save All*** button is not displayed until all the sliders have been moved. Once the button is displayed the message is removed.
5	X	Note that the ***Close(X)*** button in title bar is enabled in the Training mode.

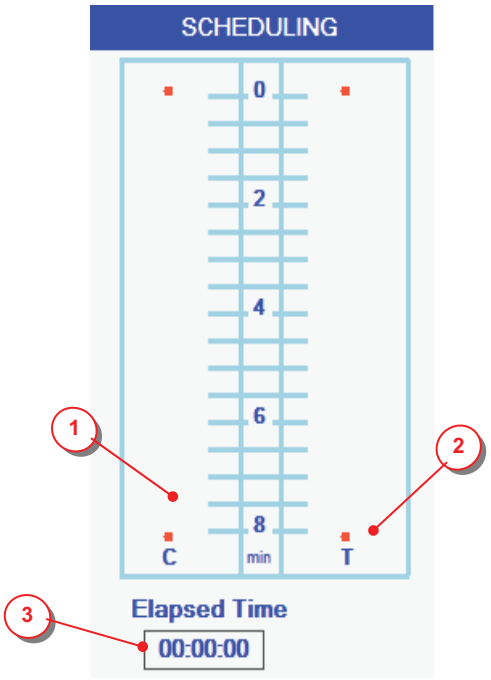
D Communications Task

The Communications (**COMM**) task is displayed in the lower left area of the MATB display. The subject's task is to change the frequency on one of four radios when the audio instruction is directed to our aircraft, which is **"NASA 504"**. When the instruction is intended for another aircraft it is ignored. The frequency is changed by selecting the radio button for the intended radio and then using the scroll bar pointers to the immediate right as needed.

D.1 COMM Initial State

Item #	Item	Description
1	Call Sign	Our call sign is ***NASA504,*** which is the only call sign the subject responds to for radio frequency changes.
2	NAV Radio Frequency	In the initial state both NAV radios are set to ***112.500***.
3	COM Radio Frequency	In the initial state both COM radios are set to ***126.500.***

D.2 COMM Session Initial State



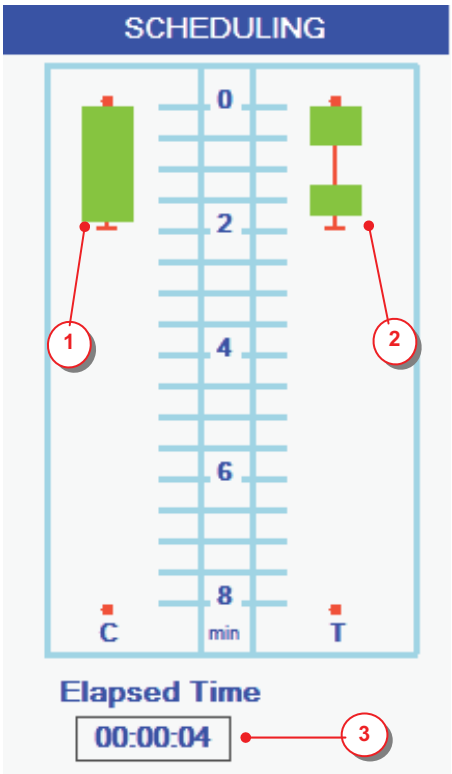
Item #	Item	Description
1	COMM Session	No COMM sessions have been processed yet
2	TRACK Session	For reference, no TRACK sessions have been processed yet either.
3	Elapsed Time	The run start event has not been processed.

D.3 COMM Session Start Event

```
<!-- Start Communications task  -->
<event startTime="0:00:05">
    <sched>
      <task>COMM</task>
      <action>START</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
```

NOTE: Sessions are in START-STOP pairs. There must be a corresponding STOP event in order for the session to be displayed on the Scheduler. See Appendix D.2 and D.4.

D.4 COMM Session Started



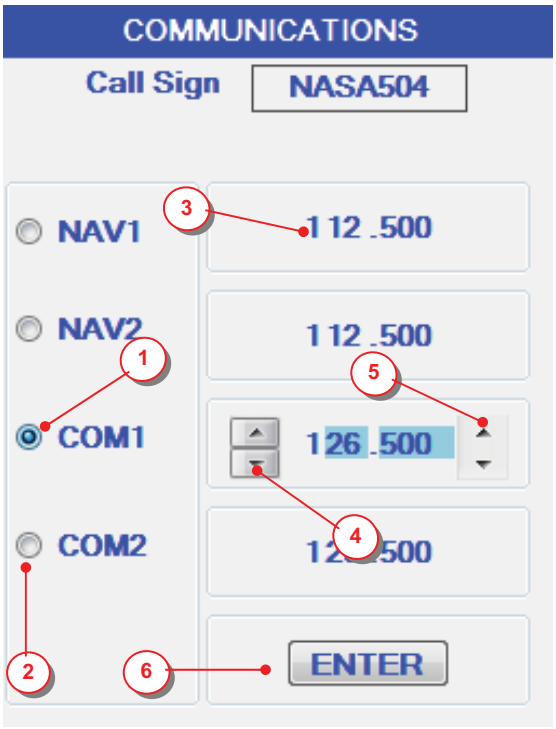
Item #	Item	Description
1	COMM Session	COMM session processed, and will be active for almost all of the 2 minute run.
2	TRACK Session	For reference, there are TRACK sessions scheduled for this run.
3	Elapsed Time	Four seconds into the run.

D.5 COMM OWN COM1 Event

```
<!-- COMM: OWN Ship Freq Change -->
<event startTime="0:00:15">
    <comm>
      <ship>OWN</ship>
      <radio>COM1</radio>
      <freq>124.575</freq>
   </comm>
</event>
```

NOTE: The call sign for OWN ship is always ***NASA504.***

D.6 COMM OWN COM1 Event Handled



Item #	Name	Description
1	COM1 Radio Button	The instruction is for NASA504, so the subject should select the COM1 radio button
2	COM2 Radio Button	Since neither COM2 nor the NAV radios will be changed their radio buttons are not selected
3	NAV1 Frequency	Since NAV1 is not selected the frequency scrollbars are not available
4	Ordinal-Scroll Bar	The ordinal scrollbar allows the subject to increment or decrement the ordinal component of the frequency
5	Decimal-Scroll Bar	The decimal scrollbar allows the subject to increment or decrement the decimal component of the frequency
6	ENTER Button	Once a radio button is selected the ***ENTER*** button becomes visible

D.7 COMM OWN COM1 Changed Entered

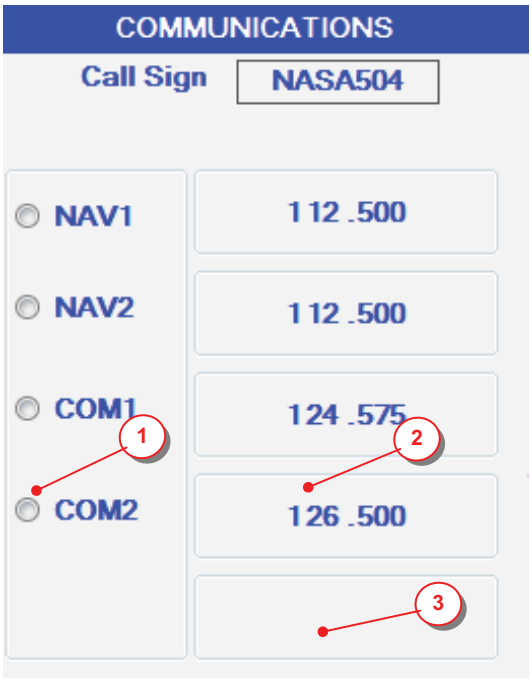
Item #	Item	Description
1	COM1 Radio Button	Once the ***ENTER*** is selected and the frequency registered the radio button is unselected.
2	COM1 Frequency	The COM radio One frequency is now ***124.575***.
3	ENTER Button	Once selected the ***ENTER*** button is no longer visible.

D.8 COMM OTHER NAV2 Event

```
<!-- COMM: OTHER Ship Freq Change -->
<event startTime="0:00:50">
    <comm>
      <ship>OTHER</ship>
      <radio>COM2</radio>
      <freq>130.725</freq>
   </comm>
</event>
```

NOTE: The call sign for OTHER may be anything other than ***NASA504.*** A number of different call signs are used in the audio files provided on the distribution media. Examples are ***ACEY 5288*** and ***CITRIS 211***. "ACEY" is the call sign for Atlantic Southeast Airlines (ASA) and "CITRIS" is the call sign for Air Tran Airlines.

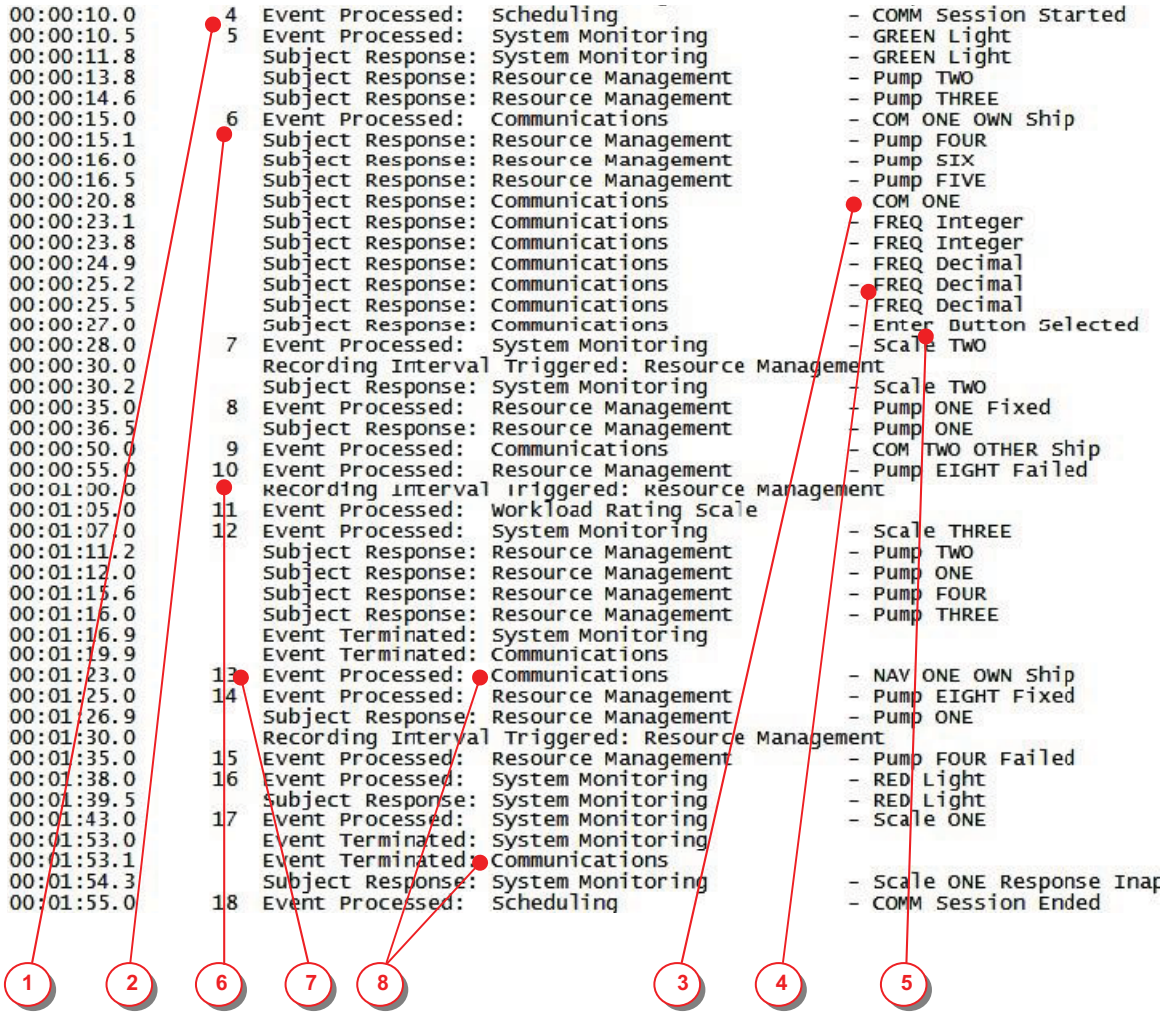
D.9 COMM OTHER COM2 Event Handled



Item #	Item	Description
1	COM2 Radio Button	Since the instruction is not for ***NASA504*** it is ignored and the radio button not selected
2	COM2 Frequency	Since the radio button is not selected the scrollbars are not visible
3	ENTER Button	Nor is the ***ENTER*** button visible

D.10 Output File Entries for COMM Events

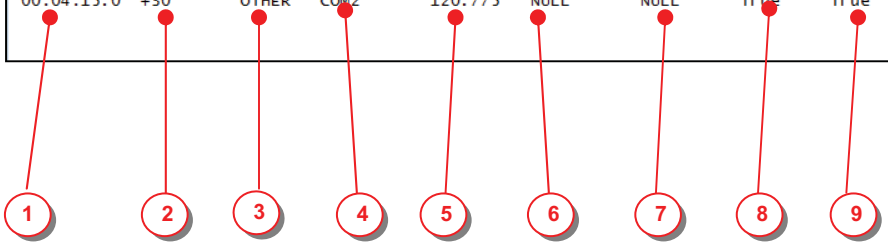
File: *MATB_yyyy_mmddhhmm.txt* entries



Item #	Event	Task	Description
1	4	Event Processed: Scheduling	Starts a Communications Session at a time of 00:00:10.
2	6	Event Processed: Communications	Processed the first COMM event, which in this example is an OWN COM1 frequency change to ***124.575***, at a time of 00:00:15.
3		Subject Response: Communications	Subject response to the above event, by selecting the COM1 radio at a time of 00:00:20.8.
4		Subject Response: Communications	Subject response with a series of integer and decimal frequency changes.
5		Subject Response: Communications	The subject registers the frequency change by pressing the ***ENTER*** button at a time of 00:00:27.0.
6	9	Event Processed: Communications	Processed the next COMM event, which in this example is an OTHER COM2 frequency change to ***130.725***, at a time of 00:00:50. Since this is not for ***NASA504,*** this instruction should be ignored.
7	13	Event Processed: Communications	Processed another COMM event. This one is a NAV ONE OWN SHIP frequency change to ***112.550.*** Note on the next line that the subject does not response to this event.
8		Event Terminated: Communications	Both events 9 and 13 terminated without subject response. In the first this was the appropriate response but the subject should have responded to event 13.

File: *COMM_yyyy_mmddhhmm.txt* entries

```
# 02-11-2011      20:42:14      COMM_2011_02112041.txt
#
# Events Filename: MATB_EVENTS-5min-Rating.xml
#
# Timeout (in seconds) = 30
#
# _T = Target, _S = Selected
# R_ = Radio,  F_ = Frequency
#
#-TIME-     -RT-  -SHIP-  -RADIO_T-  -FREQ_T-  -RADIO_S-  -FREQ_S_  -R_OK-   -F_OK-   -REMARKS
#-------------------------------------------------------------------------------------------------------------
 00:00:40.0   -30      OWN     COM1       124.575   NULL       NULL      False    False  -Event Timedout
 00:01:50.0   +30      OTHER   COM2       130.725   NULL       NULL      True     True
 00:02:28.3  8.5       OTHER   NAV2       115.050   NAV2       115.050   False    False
 00:03:23.7 12.0       OWN     COM1       126.450   COM1       126.450   True     True
 00:04:15.0  +30       OTHER   COM2       120.775   NULL       NULL      True     True  -Appropriate Subject Response
```



Item #	Item	Description
1	Run time of response	Elapsed time to tenth of a second
2	Reaction Time	The number of seconds the subject takes to respond to the above event
3	Target Ship	OWN (***NASA504***) or OTHER from the audio file instruction utterance.
4	Target Radio	COM1, COM2, NAV1 or NAV2 from the audio file instruction utterance.
5	Target Frequency	Frequency from the audio file instruction utterance.
6	Selected Radio	COM1, COM2, NAV1, NAV2 or NULL if no radio is selected. When the instruction is targeted to OTHER, NULL is the correct responses.
7	Selected Frequency	When the instruction is targeted to OTHER, NULL is the correct responses.
8	Correct Radio Selected	Boolean result from a comparison of target and selected radio. When the target ship is OTHER and selected radio is NULL, the result is **true**.
9	Correct Frequency Set	Boolean result from a comparison of target and selected frequency. When the target ship is OTHER and selected frequency is NULL, the result is **true**.

E Resource Management Task

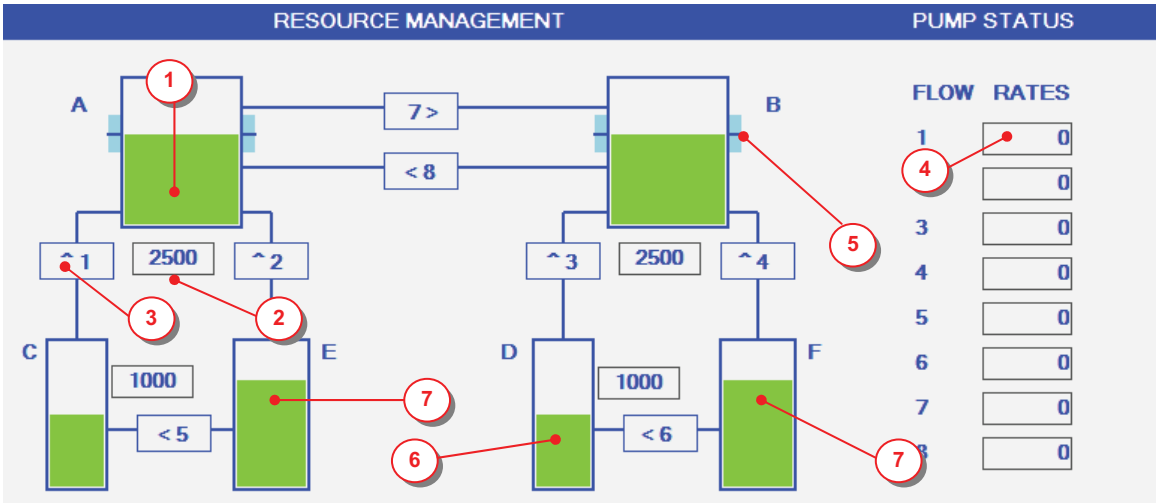
The Resource Management (**RESMAN**) task is displayed in the lower center and right of the MATB display. The subject's task is to maintain the fluid volume in tanks A and B in the indicated range through the use of one or more of the available eight pumps. In the normal state all the pumps are available provided the source tank is not empty. However in the non-normal state one or more of the pumps is inoperative.

E.1 RESMAN Event to Include Task

```
<!-- Start Resource Management task  -->
<event startTime="0:00:01">
    <sched>
      <task>RESMAN</task>
      <action>START</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
```

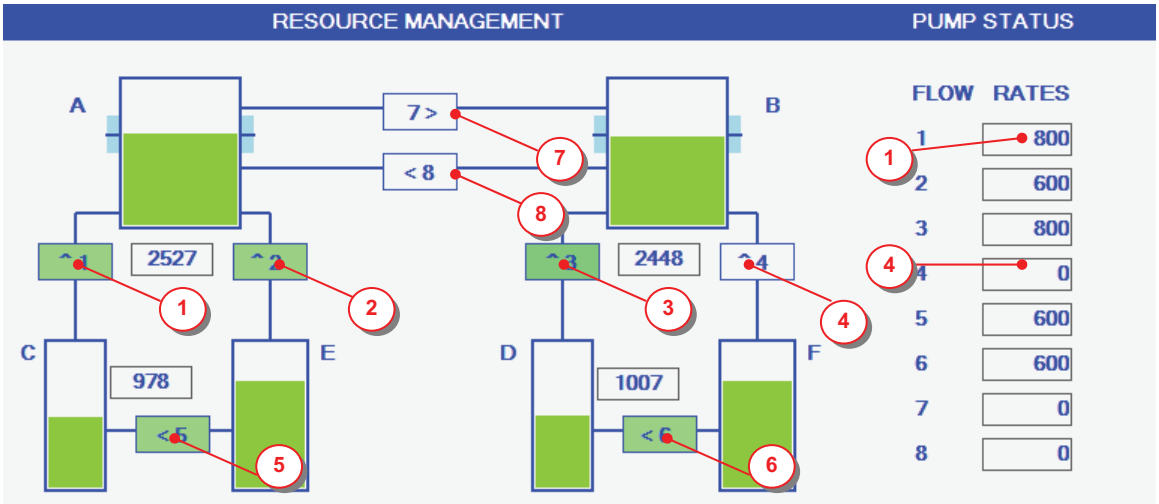
NOTE: Use "<task>RESSYS</task>" to start both **RESMAN** and **SYSMON** tasks with a single entry

E.2 RESMAN Initial State



Item #	Item	Description
1	Fluid Volume Visual Indicator	The **GREEN** bar shows the current fluid level in the tank. The initial level is 2500 units for both tanks A and B with the consumption beginning as soon as the RESMAN-START event is processed (see Appendix E.1 above).
2	Fluid Volume Numeric Indicator	When the volume is within the desired 2000 to 3000 range the value is displayed in blue. If above or below the value is **RED**.
3	Pump number, direction and state	This is the ON/OFF switch for pump ONE, which initially is OFF. The caret shows that the pump source is tank C and the destination is tank A. When a pump in ON it is colored **GREEN** and the background color when OFF. All eight pumps operate the same.
4	Pump Rate Numeric Indicator	Indicates the current rate for pump number one. When the pump is off or inoperative the rate will show a flow rate of 0 units per minute. When a pump is ON the preset flow rate will be shown. Both the consumption rates of tanks A & B and the flow rate of each of the pumps is configurable.
5	Target Range Indicator	The light blue shaded blocks indicate the desired range for tank A and B volume, which is 2000 to 3000 units.
6	Fluid Volume Visual Indicator	The initial volume of tank D is 1000 units. Pump 3 transfers fluid out and pump 6 transfers fluid in. Tank C works the same, but with pumps 1 and 5.
7	Tank E & F	These two tanks are unlimited sources for the other four tanks.

E.3 RESMAN Selected Pumps Activated By User



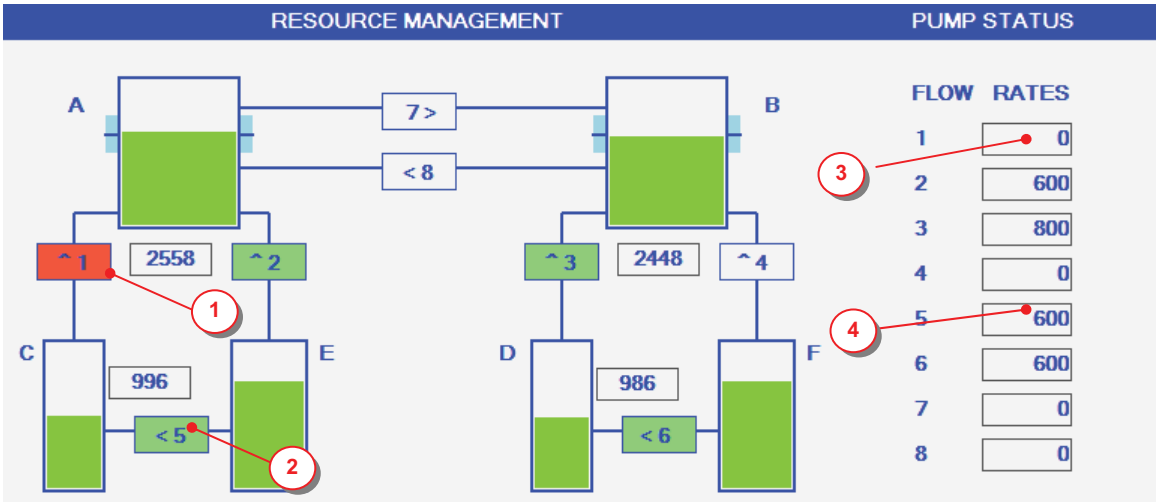
Item #	Item	Description
1	Pump One	The **GREEN** background indicates that the subject turned pump ONE ON. The flow rate for pump ONE is 800 units per minute.
2	Pump Two	The **GREEN** background indicates that the subject turned pump TWO ON.
3	Pump Three	The **GREEN** background indicates that the subject turned pump THREE ON.
4	Pump Four	The lack of a distinctive color background indicates that pump FOUR is OFF, which is verified by a 0 units per minute flow rate.
5	Pump Five	The **GREEN** background indicates that the subject turned pump FIVE ON.
6	Pump Six	The **GREEN** background indicates that the subject turned pump SIX ON.
7	Pump Seven	The lack of a distinctive background color indicates that pump SEVEN is OFF.
8	Pump Eight	The lack of a distinctive background color indicates that pump EIGHT is OFF.

E.4 RESMAN Event to Fail a Pump

```
<!-- RESMAN: Fail pump 1  -->
<event startTime="0:00:09">
    <resman>
      <fail>P1</fail>
   </resman>
</event>
```

NOTE: "P1" represents pump one.

E.5 RESMAN Pump ONE Failed



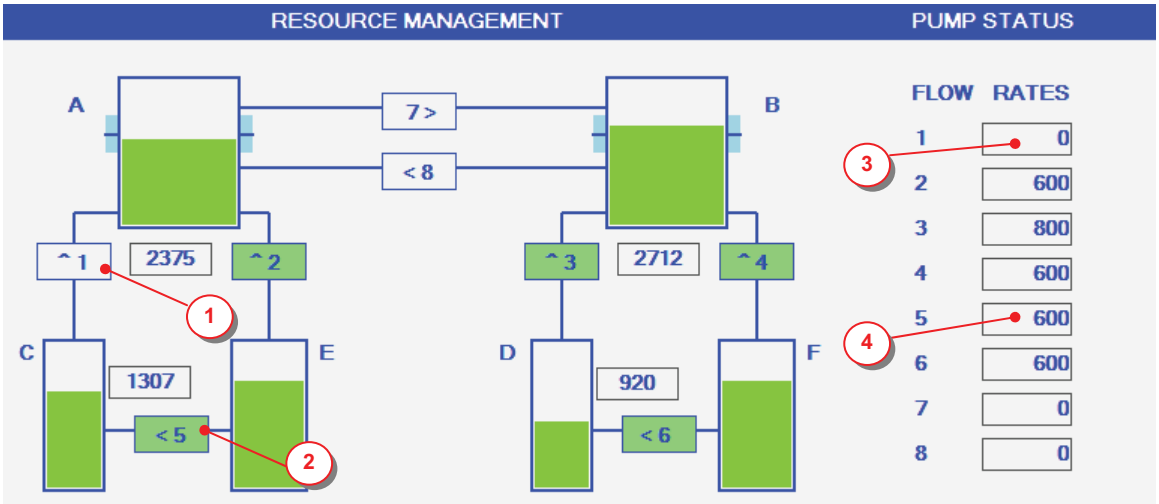
Item #	Item	Description
1	Pump One	The **RED** background indicates that pump ONE has failed as the result of the event being processed.
2	Pump Five	The **GREEN** background indicates that the subject turned the pump ON. Only a single pump is affected by an event, which in this case was pump ONE.
3	Flow Rate	Since pump ONE failed, the flow rate is 0 units per minute.
4	Flow Rate	Since pump FIVE is on, the flow rate remains at 600 units per minute.

E.6 RESMAN Event to Fix a Pump

```
<!-- RESMAN: Fix pump 1  -->
<event startTime="0:00:35">
    <resman>
      <fix>P1</fix>
   </resman>
</event>
```

NOTE: "P1" represents pump one.

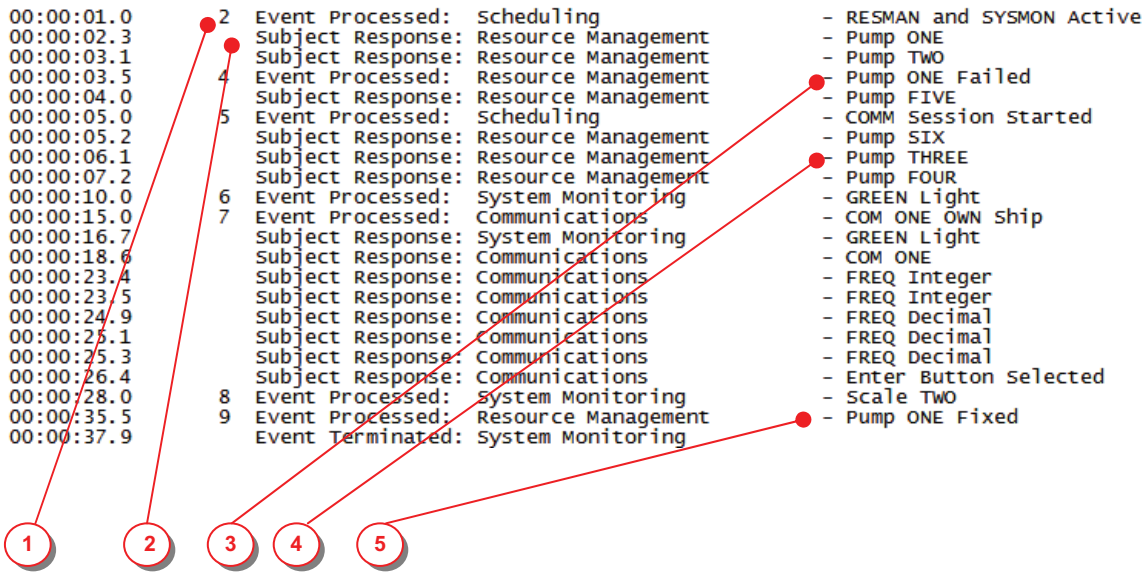
E.7 RESMAN Pump ONE Fixed



Item #	Item	Description
1	Pump One	When fixed, a pump returns to the initial state, which is OFF, no matter what state it was in when it failed.
2	Pump Five	The **GREEN** background indicates that pump FIVE is still ON.
3	Flow Rate	The flow rate of pump ONE is 0, since when fixed it returns to the initial state which is OFF.
4	Flow Rate	Since pump FIVE is still on, the flow rate remains at 600 units per minute.

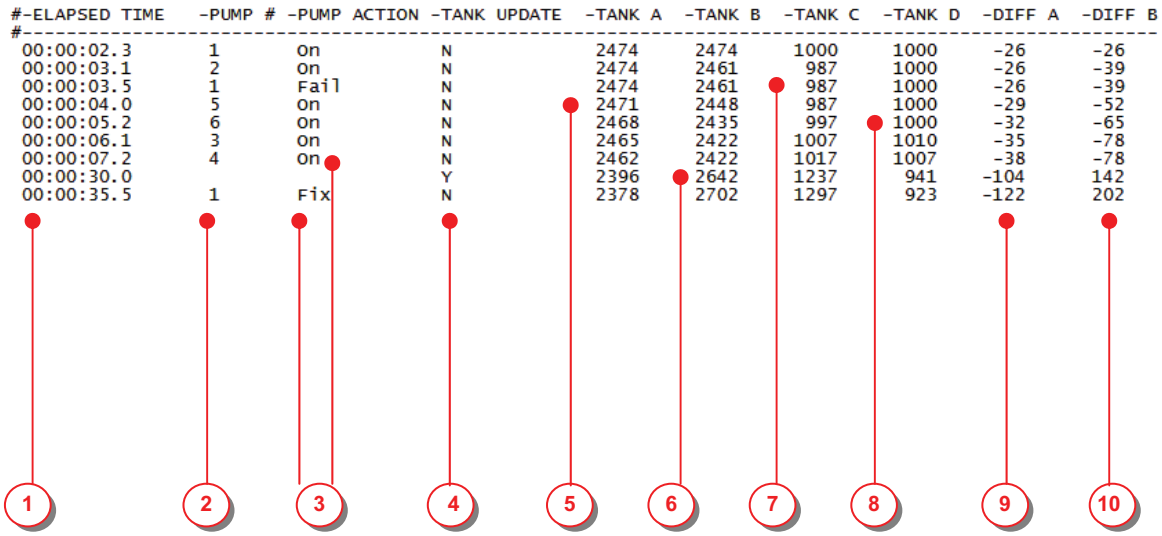
E.8 Output File Entries for RESMAN Events

File: *MATB_yyyy_mmddhhmm.txt* entries



Item #	Event	Action	Description
1	1	Event Processed: Scheduling	The Resource Management task is active. Tank A and B consumption begins.
2	2	Subject Responses: Resource Management	Pumps ONE and TWO turned ON at times of 00:00:2.3 and 00:00:03.1.
3		Event Processed: Resource Management	RESMAN event processed. Pump ONE was failed.
4	3	Subject Responses: Resource Management	Pumps FIVE, SIX, THREE, and FOUR all turned on by the subject.
5	5	Event Processed: Resource Management	RESMAN event processed. Pump ONE was fixed.

File: *RESMAN_yyyy_mmddhhmm.txt* entries



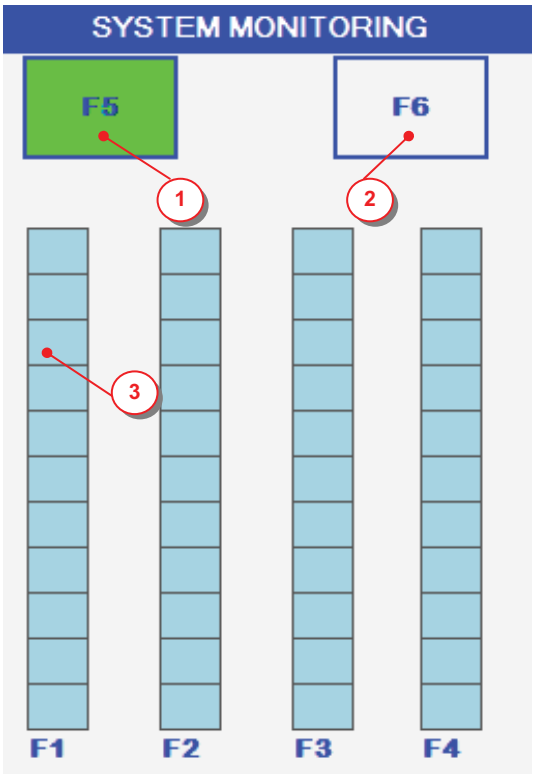
#-ELAPSED TIME	-PUMP #	-PUMP ACTION	-TANK UPDATE	-TANK A	-TANK B	-TANK C	-TANK D	-DIFF A	-DIFF B
00:00:02.3	1	On	N	2474	2474	1000	1000	-26	-26
00:00:03.1	2	On	N	2474	2461	987	1000	-26	-39
00:00:03.5	1	Fail	N	2474	2461	987	1000	-26	-39
00:00:04.0	5	On	N	2471	2448	987	1000	-29	-52
00:00:05.2	6	On	N	2468	2435	997	1000	-32	-65
00:00:06.1	3	On	N	2465	2422	1007	1010	-35	-78
00:00:07.2	4	On	N	2462	2422	1017	1007	-38	-78
00:00:30.0			Y	2396	2642	1237	941	-104	142
00:00:35.5	1	Fix	N	2378	2702	1297	923	-122	202

Item #	Item	Description
1	Run time of response	Elapsed time to tenth of a second
2	Pump Number	Pump ONE turned on.
3	Pump Action	“On” and “Off” are user responses “Fail” and “Fix” are the result of event processing
4	Tank Update	“N” (NO) when the tank volumes are being recorded due to a event or user actions, and “Y” (YES) when triggered by the recording interval timer
5	Tank A Volume	2471 units at a time of 00:00:04.0 when Pump FIVE is turned ON.
6	Tank B Volume	2642 units as recorded when triggered by a time interval, 00:00:30.0
7	Tank C Volume	987 units when pump ONE failed at a time of 00:00:03.5
8	Tank D Volume	1000 units when pump 6 was turned on
9	Tank A Differential from the initial condition	-122 (2378 - 2500) at time 00.00.35.5.
10	Tank B Differential from the initial condition	2032 (2707 – 2500) at time 00.00.35.5.

F System Monitoring Task

The System Monitoring (**SYSMON**) task is displayed in the upper left of the MATB display. The subject's task is to return the two lights and four scales to the normal position as soon as it is noticed that they are in a non-normal state. The **GREEN** light is normally ON with OFF as the non-normal state. The **RED** light is normally OFF with ON as the non-normal state. The positions of four scales update randomly around the center in the normal state and either shift to the top or bottom regions of the scale in the non-normal state.

F.1 SYSMON Initial State



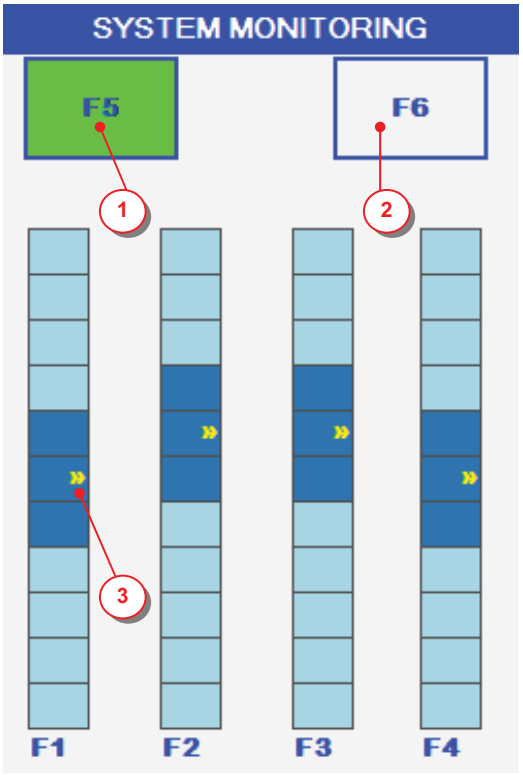
Item #	Name	Description
1	Light Normally On	**GREEN** is the initial state of this light.
2	Light Normally Off	In the initial state the color of this light is the same as the rest of the MATB background
3	Scale One of Four	When inactive the background color of the scales is light blue.

F.2 SYSMON Event to Activate the Normal State

```
<!-- Start System Monitoring tasks  -->
<event startTime="0:00:01">
  <sched>
      <task>SYSMON</task>
      <action>START</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
```

NOTE: Use "<task>RESSYS</task>" to start both **RESMAN** and **SYSMON** tasks with a single entry.

F.3 SYSMON Normal State

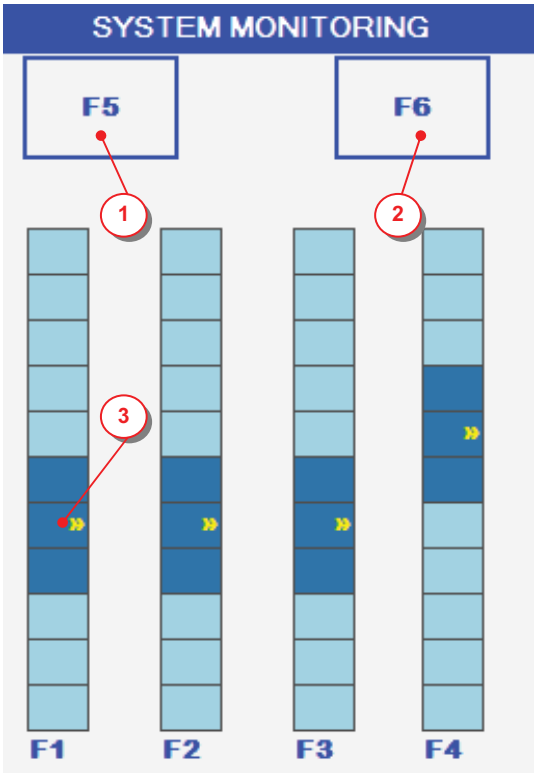


Item #	Name	Description
1	Light Normally On	In the normal state the color of this light is **GREEN**.
2	Light Normally Off	In the normal state the background color of this light is the same as the rest of the MATB background.
3	Scale One of Four	When active the foreground color of the scales is a dark blue with a yellow “right sift operator” sign in the center segment. The position of each is continuously randomly updated independently.

F.4 SYSMON Event to Turn the GREEN Light OFF

```
<!-- #1. SYSMON LIGHT -->
<!-- Start System Monitoring and Turn Normally ON to OFF -->
<event startTime="0:00:03">
  <sysmon activity="START">
      <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
</event>
```

F.5 SYSMON GREEN Light OFF Event

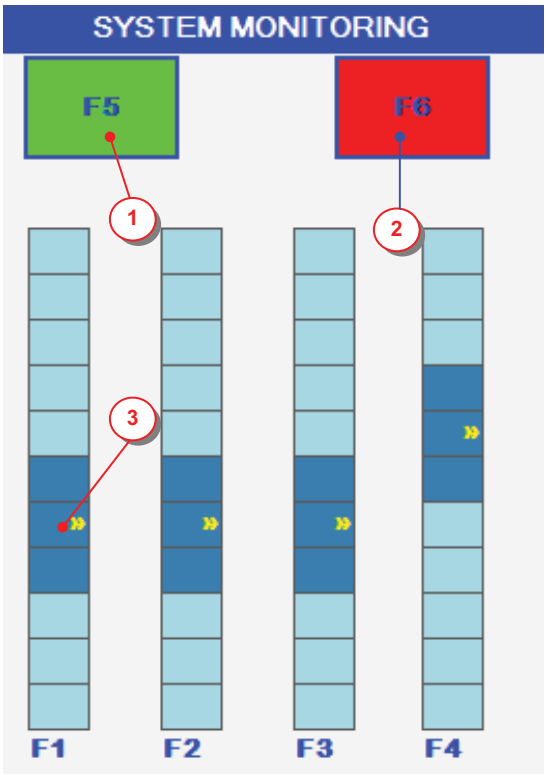


Item #	Name	Description
1	Light Normally On	When a **GREEN** light event is processed color of this light becomes the same as the rest of MATB's background.
2	Light Normally Off	This light remains in the normal state.
3	Scale One of Four	The scales remain in the normal state.

F.6 SYSMON Event to Turn the RED Light ON

```
<!-- #4. SYSMON LIGHT -->
<!-- System Monitoring - Turn Normally OFF to ON -->
<event startTime="0:01:03">
  <sysmon>
      <monitoringLightType>RED</monitoringLightType>
   </sysmon>
</event>
```

F.7 SYSMON RED Light ON Event

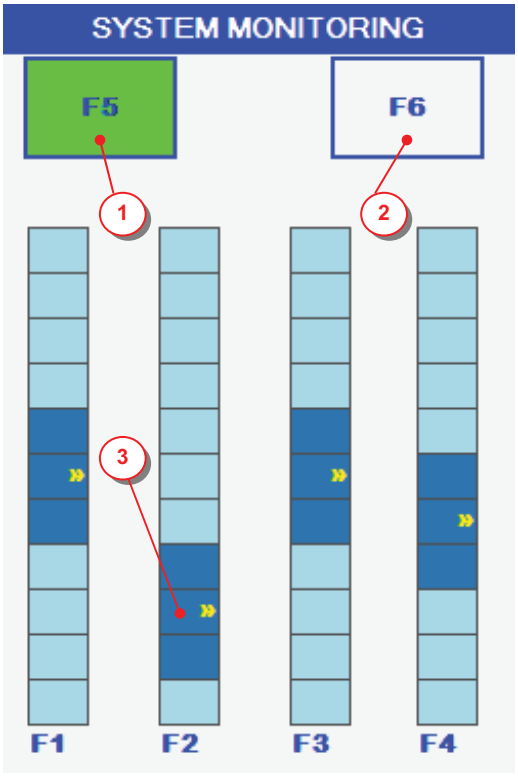


Item #	Name	Description
1	Light Normally On	This light remains in the normal state.
2	Light Normally Off	When a **RED** light event is processed the background color of this light becomes **RED**.
3	Scale One of Four	The scales remain in the normal state.

F.8 SYSMON Event to Move Scale Two DOWN

```
<!-- SYSMON: SCALE TWO DOWN -->
<event startTime="0:00:28">
    <sysmon>
      <monitoringScaleNumber>TWO</monitoringScaleNumber>
      <monitoringScaleDirection>DOWN</monitoringScaleDirection>
   </sysmon>
</event>
```

F.9 SYSMON Scale Two DOWN UP

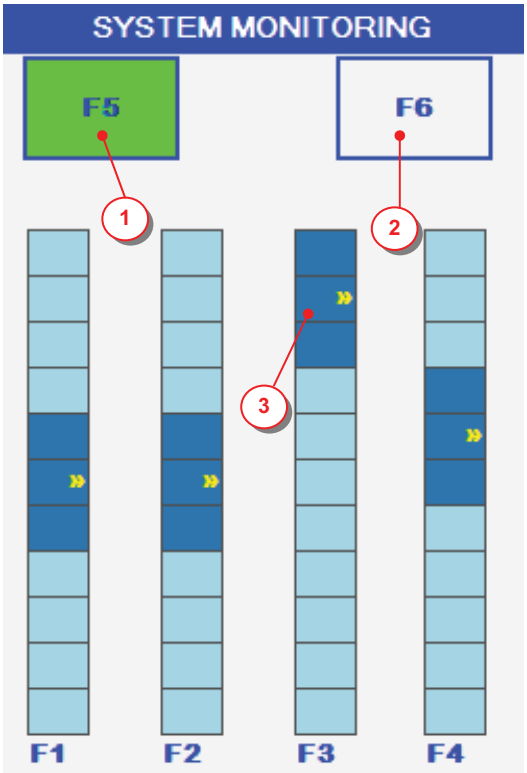


Item #	Name	Description
1	Light Normally On	This light remains in the normal state.
2	Light Normally Off	This light remains in the normal state.
3	Scale Two of Four	Scale two indicator moves below the normal range. The other scales remain in the normal state and the position of each is independently and continuously updated.

F.10 SYSMON Event to Move Scale Three UP

```
<!-- SYSMON: SCALE THREE UP -->
<event startTime="0:01:07">
    <sysmon>
      <monitoringScaleNumber>THREE</monitoringScaleNumber>
      <monitoringScaleDirection>UP</monitoringScaleDirection>
   </sysmon>
</event>
```

F.11 SYSMON Scale Three UP



Item	Name	Description
1	Light Normally On	This light remains in the normal state.
2	Light Normally Off	This light remains in the normal state.
3	Scale Four of Four	Scale three indicator moves above the normal range. The other scales remain in the normal state and the position of each is independently and continuously updated.

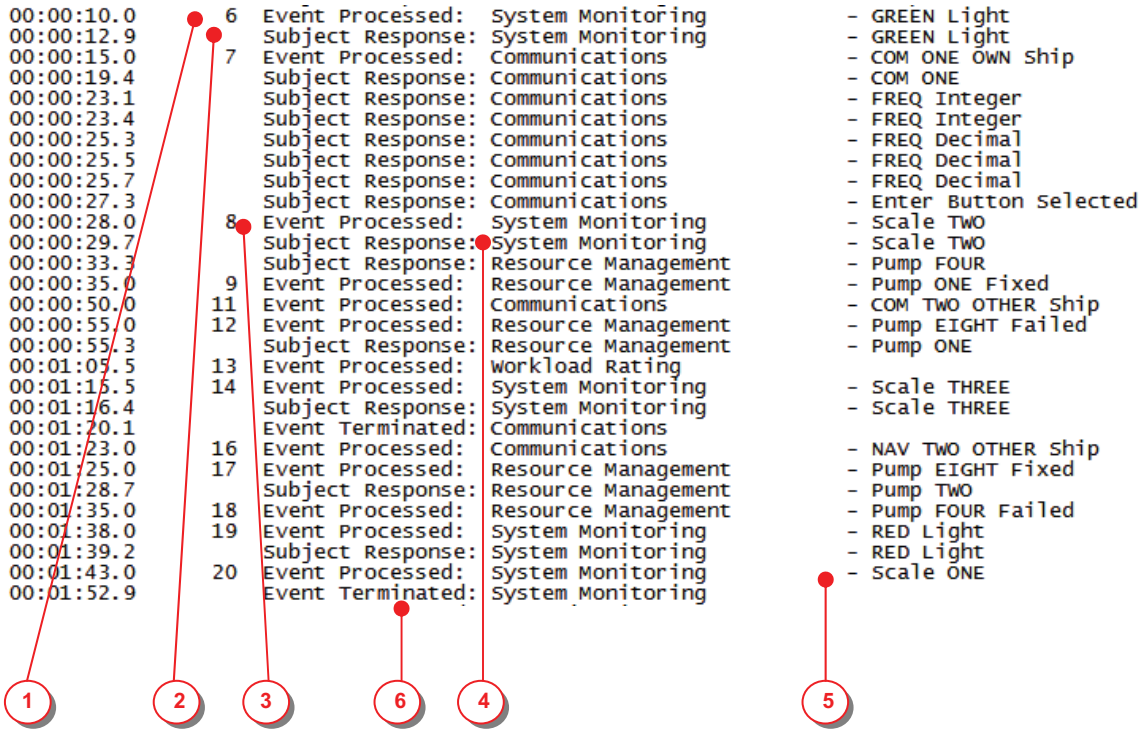
F.12 SYSMON Return to the Normal State

The **SYSMON** task returns to the normal state by clicking with the mouse on the appropriate light or scale, or selecting the appropriate function key (e.g. F1 or Scale One, and F6 for the light normally off).

SYSMON will also return to the normal state when the event timeout value is reached before the appropriate response is made.

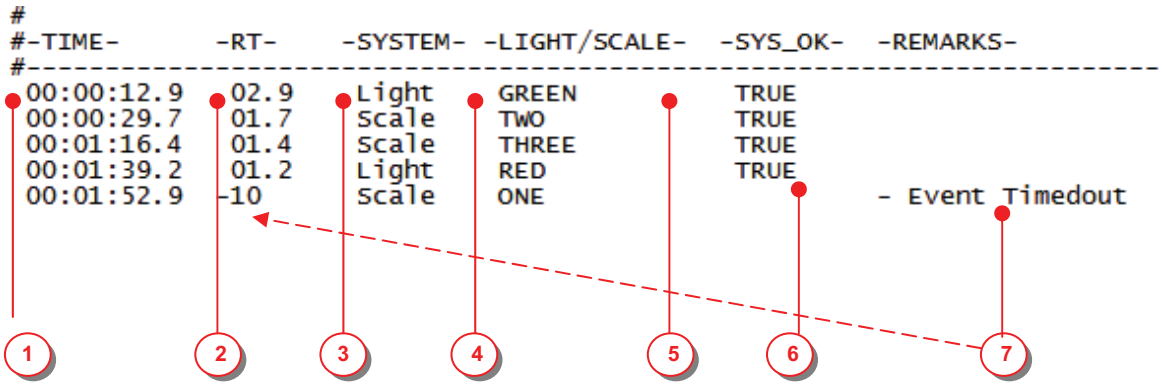
F.13 *Output File Entries for SYSMON Events*

File: *MATB_yyyy_mmddhhmm.txt* entries



Item #	Event	Task	Description
1	6	Event Processed: System Monitoring	Processed the first **SYSMON** event, which in this example is a **GREEN** light off at a time of 00:00:10.0
2		Subject Response: System Monitoring	The **GREEN** light is turned back on at a time of 00:00:12.9
3	8	Event Processed: System Monitoring	Scale TWO processed at 00:00:28.0
4		Subject Response: System Monitoring	The Scale TWO is returned to the normal state on at a time of 00:00:29.7
5	20	Event Processed: System Monitoring	Scale ONE processed at 00:01:43.0
6		Event Terminated: System Monitoring	Subject failed to respond to the above event within the allowed time limit.

File: *SYSM_yyyy_mmddhhmm.txt* entries

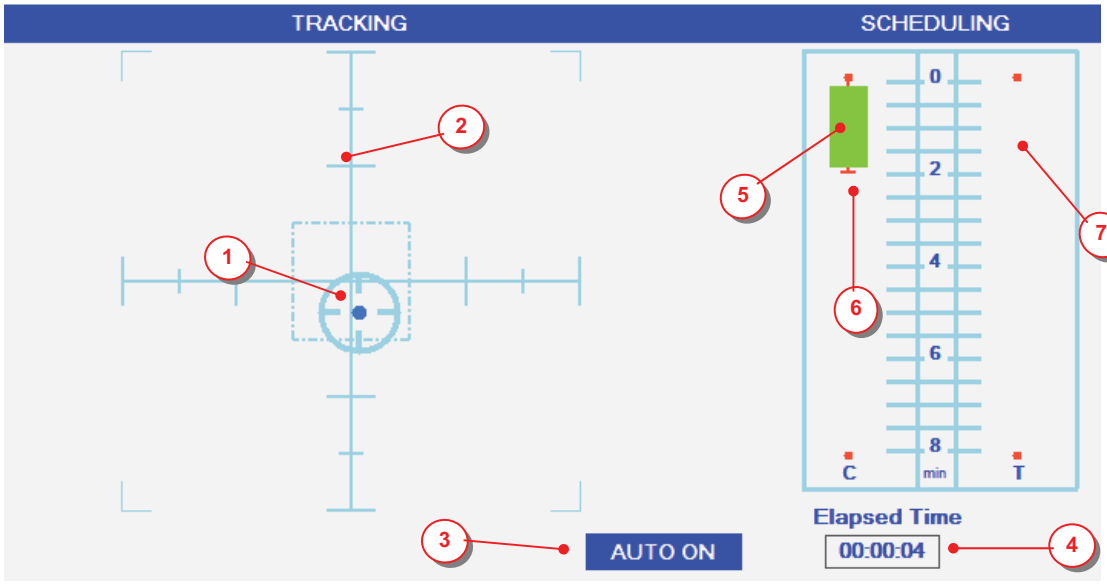


Item #	Item	Description
1	Run time of response	Elapsed time to tenth of a second
2	Elapsed time since event processed	Event processed at 00:10.0 with response at 00:12.9, which equals a 02.9 second response time.
3	Light system processed	Light event processed.
4	Subject response	Subject responded by attempting to turn the **GREEN** light ON.
5	Was this the correct response?	Yes, this was a **GREEN** light turned OFF event so True for the desired response.
6	Was this the correct response?	Yes, this was a **RED** light turned ON event so TRUE for the desired response.
7	Event Timedout	The **SCALE One** event processed at a time 01:43.0 was not correctly responded to in the 10 second timeout window, so -10 response time recorded with the appropriate remark that the "Event Timedout".

G Tracking Task

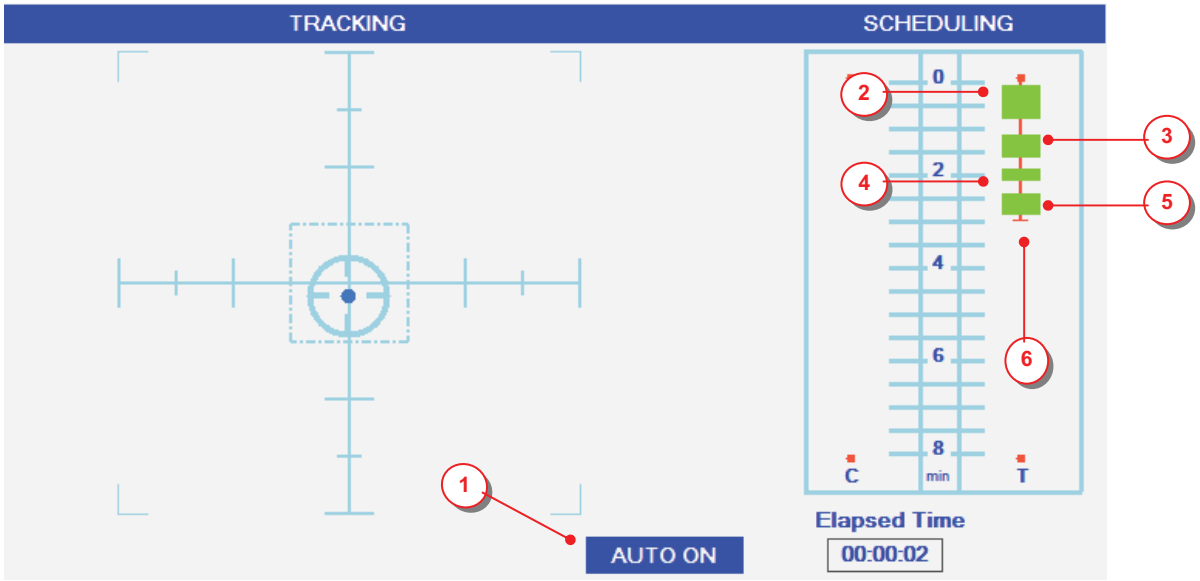
The Tracking (**TRACK**) task is displayed in the top center of the MATB display. The subject's task is to keep the target in the center of the grid, when the task is in manual mode. When the task is in automatic mode (i.e. autopilot) no action is required by the subject. The current mode is displayed in a text box below and to the right of the grid.

G.1 TRACK Initial State



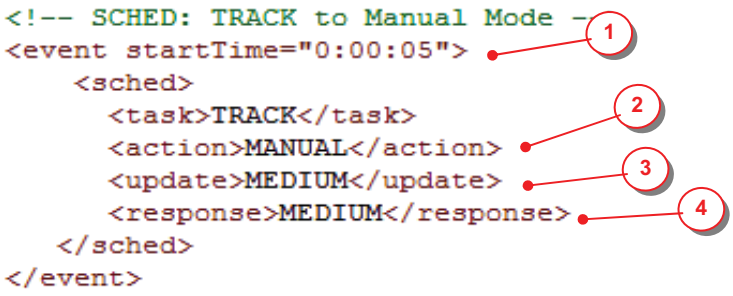
Item #	Item	Description
1	The Target	In manual mode the subject uses the joystick to keep the target centered on the crosshairs.
2	Grid	The track grid lines are a light blue See appendix G.4 for color change during “Manual” mode.
3	Mode indicator	In automatic mode MATB controls the target.
4	Elapsed Time	Four seconds after the run started
5	Communication Session	There is one communications session during this run.
6	Run End Time	The **RED “T”** provides a visual cue that this run is two minutes long.
7	Tracking Sessions	No tracking sessions are scheduled for this run.

G.2 TRACK Session Schedule



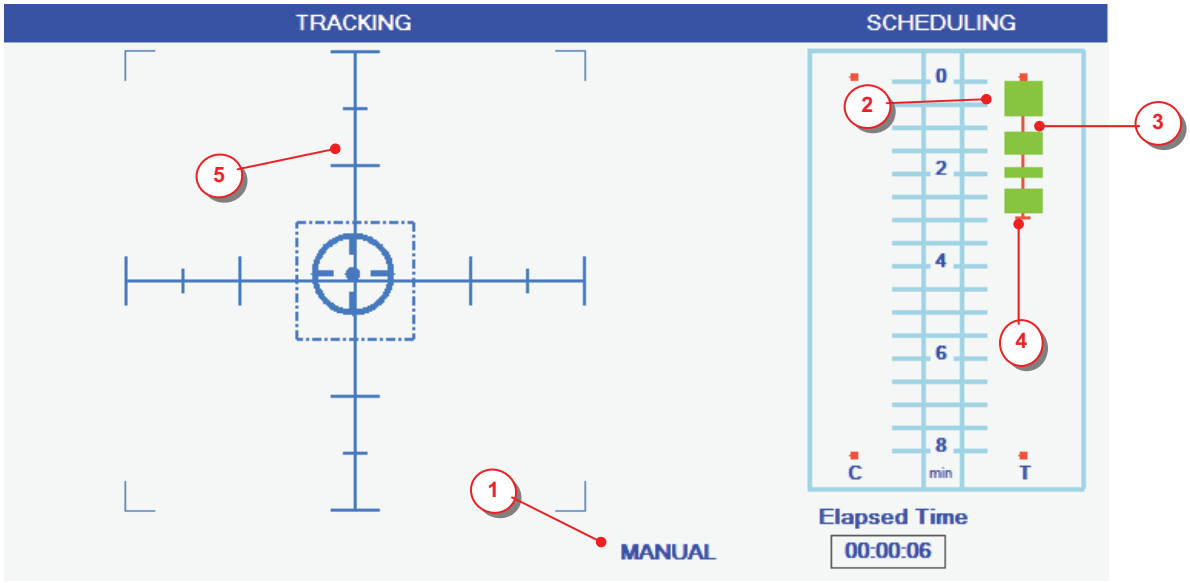
Item #	Item	Description
1	Mode indicator	In automatic mode, MATB controls the target.
2	Tracking Session	First manual mode session is about to start and lasts for 45 seconds.
3	Tracking Session	After 20 seconds in automatic mode the second manual session begins a little more than a minute from now.
4	Tracking Session	After returning to automatic mode, there is a third manual session, which is much shorter than the others in this run.
5	Tracking Session	The last manual mode session starts about two and one half minutes from now.
6	Run End Time	The **RED "T"** provides a visual cue that this run is three minutes long.

G.3 TRACK Session Manual Event



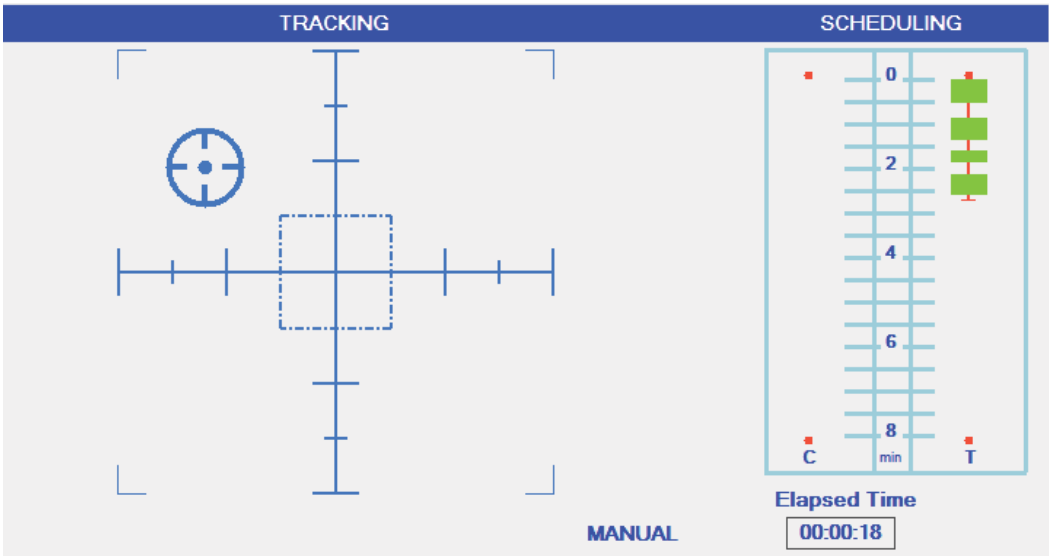
Item #	Item	Description
1	Event startTime	Five seconds into the run
2	Action	Manual mode. The subject controls the position of the target with the joystick.
3	Update	Amount of random target movement per update cycle.
4	Response	Amount of influence the joystick has on target movement per update cycle.

G.4 TRACK Manual Session Started



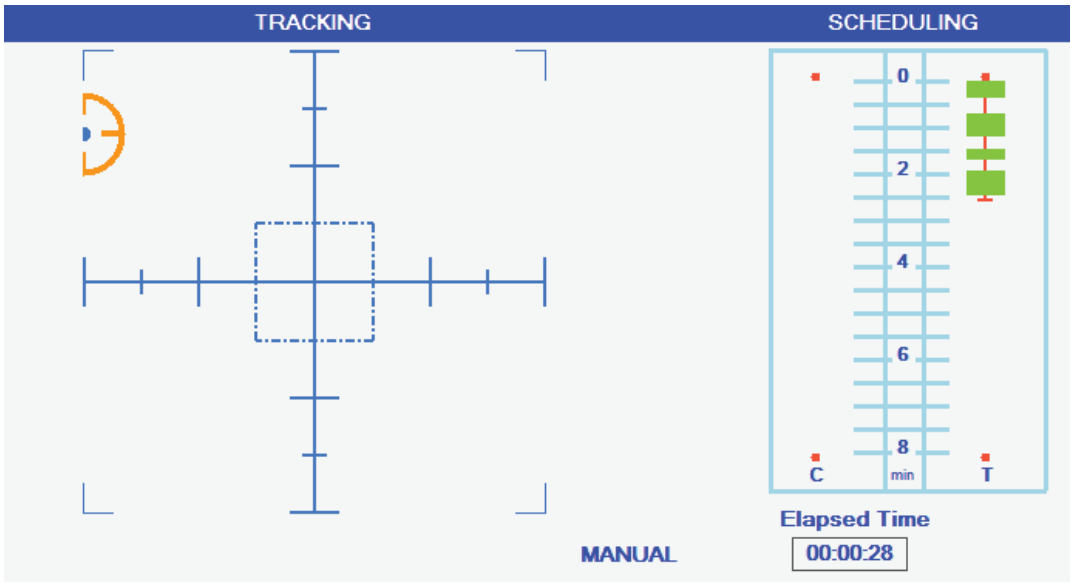
Item #	Item	Description
1	Manual mode.	The subject controls the position of the target with the joystick.
2	TRACK Task Manual	The track task is active whenever the **GREEN** bar is visible.
3	TRACK Task Automatic	There is a 30 automatic mode segment before the second manual session starts.
4	Run end time	The **RED "T"** indicates the end of the run. Here a little less than three minutes from now.
5	Grid	The track grid lines are a dark blue. See the appendix for color changes during "Auto" mode.

G.5 TRACK Manual Session – Target Drift



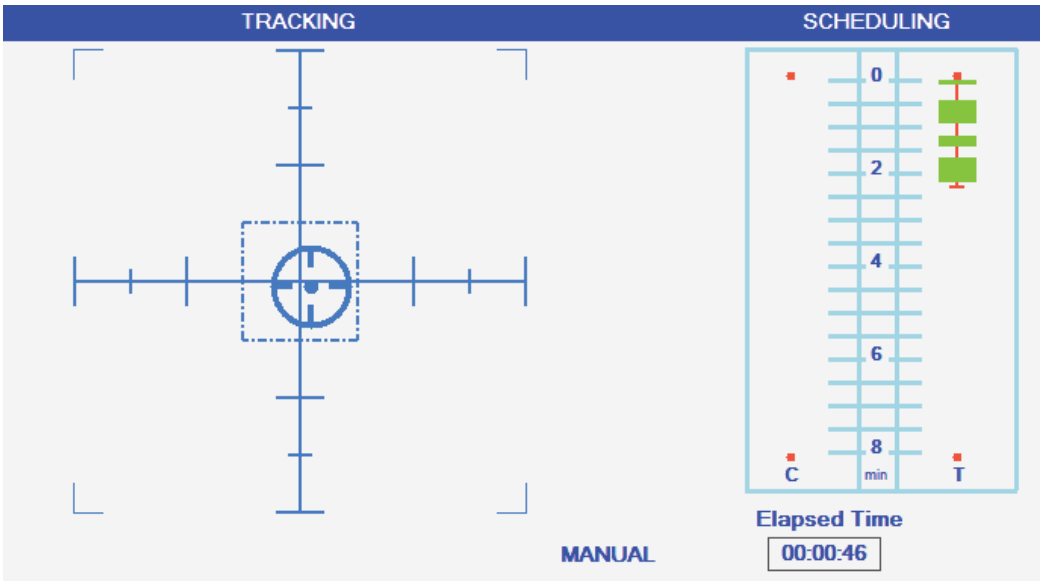
Note the location of the target in the northwest quadrant.

G.6 TRACK Manual Session – Target Caged



Now note the location of the target in the northwest quadrant. When the target is off the grid, its outer ring is drawn in **ORANGE** with the center shown at the point of departure.

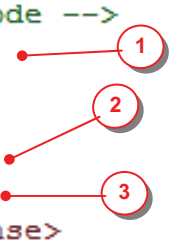
G.7 TRACK Manual Session – Target Controlled



The subject is now influencing the position of the target with the joystick. The task is to keep the target in the center of the grid.

G.8 TRACK Session Auto Event

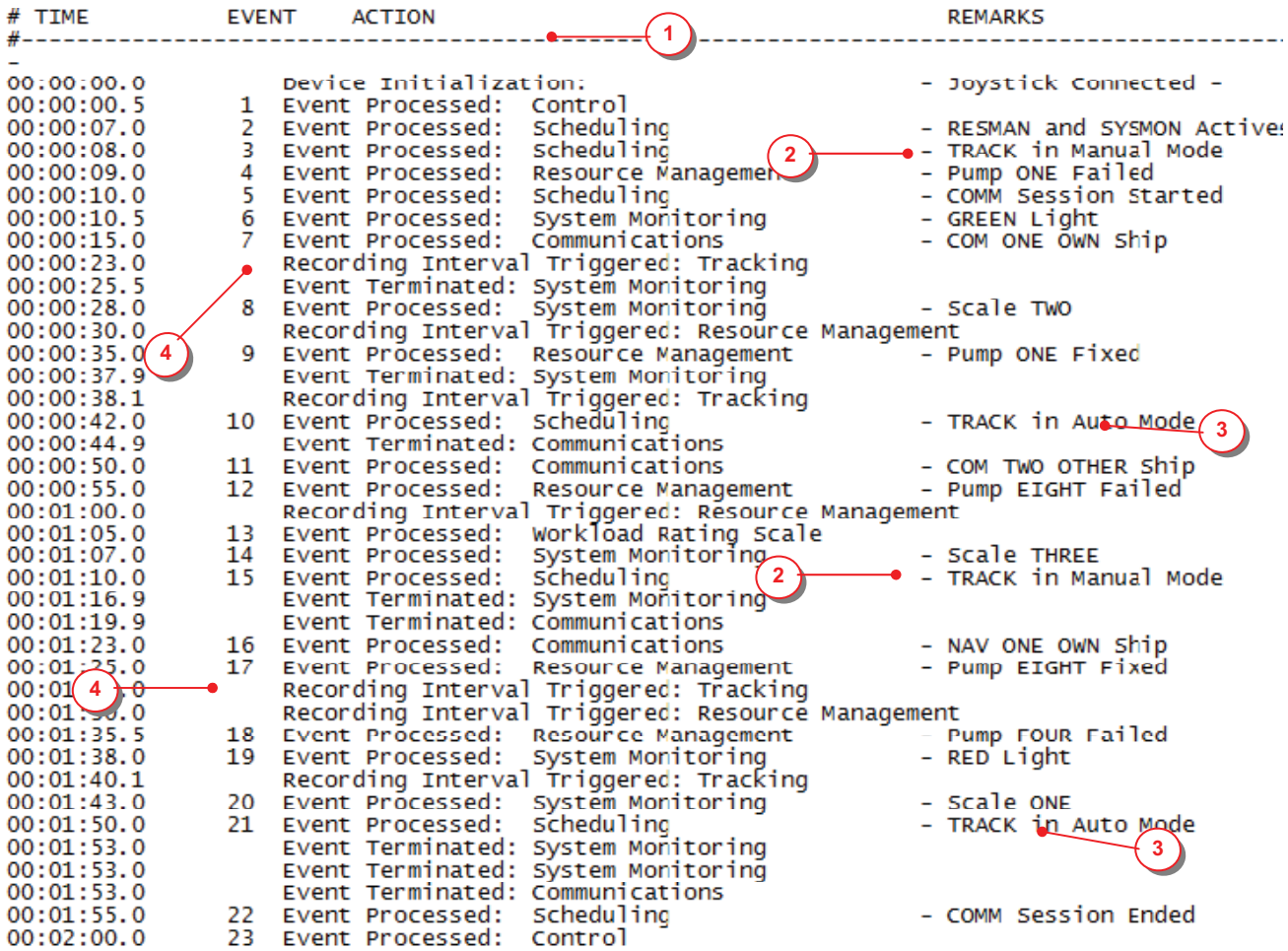
```
<!-- SCHED: TRACK to Auto Mode -->
<event startTime="0:00:50">
    <sched >
      <task>TRACK</task>
      <action>AUTO</action>
      <update>NULL</update>
      <response>NULL</response>
   </sched>
</event>
```



Item #	Item	Description
1	Event startTime	Fifty seconds into the run
2	Action	Automatic mode. The autopilot controls the position of the target.
3	Update / Response	Target update and joystick responses are not used in auto mode.

G.9 Output File Entries for TRACK Events

File: ***MATB_yyyy_mmddhhmm.txt*** entries




```
# TIME          EVENT    ACTION                                  REMARKS
#-------------------------------------------------------------------------------
-
00:00:00.0              Device Initialization:                   - Joystick Connected -
00:00:00.5        1     Event Processed:  Control
00:00:07.0        2     Event Processed:  Scheduling             - RESMAN and SYSMON Active
00:00:08.0        3     Event Processed:  Scheduling             - TRACK in Manual Mode
00:00:09.0        4     Event Processed:  Resource Management    - Pump ONE Failed
00:00:10.0        5     Event Processed:  Scheduling             - COMM Session Started
00:00:10.5        6     Event Processed:  System Monitoring      - GREEN Light
00:00:15.0        7     Event Processed:  Communications         - COM ONE OWN Ship
00:00:23.0              Recording Interval Triggered: Tracking
00:00:25.5              Event Terminated: System Monitoring
00:00:28.0        8     Event Processed:  System Monitoring      - Scale TWO
00:00:30.0              Recording Interval Triggered: Resource Management
00:00:35.0        9     Event Processed:  Resource Management    - Pump ONE Fixed
00:00:37.9              Event Terminated: System Monitoring
00:00:38.1              Recording Interval Triggered: Tracking
00:00:42.0       10     Event Processed:  Scheduling             - TRACK in Auto Mode
00:00:44.9              Event Terminated: Communications
00:00:50.0       11     Event Processed:  Communications         - COM TWO OTHER Ship
00:00:55.0       12     Event Processed:  Resource Management    - Pump EIGHT Failed
00:01:00.0              Recording Interval Triggered: Resource Management
00:01:05.0       13     Event Processed:  Workload Rating Scale
00:01:07.0       14     Event Processed:  System Monitoring      - Scale THREE
00:01:10.0       15     Event Processed:  Scheduling             - TRACK in Manual Mode
00:01:16.9              Event Terminated: System Monitoring
00:01:19.9              Event Terminated: Communications
00:01:23.0       16     Event Processed:  Communications         - NAV ONE OWN Ship
00:01:25.0       17     Event Processed:  Resource Management    - Pump EIGHT Fixed
00:01:30.0              Recording Interval Triggered: Tracking
00:01:30.0              Recording Interval Triggered: Resource Management
00:01:35.5       18     Event Processed:  Resource Management    - Pump FOUR Failed
00:01:38.0       19     Event Processed:  System Monitoring      - RED Light
00:01:40.1              Recording Interval Triggered: Tracking
00:01:43.0       20     Event Processed:  System Monitoring      - Scale ONE
00:01:50.0       21     Event Processed:  Scheduling             - TRACK in Auto Mode
00:01:53.0              Event Terminated: System Monitoring
00:01:53.0              Event Terminated: System Monitoring
00:01:53.0              Event Terminated: Communications
00:01:55.0       22     Event Processed:  Scheduling             - COMM Session Ended
00:02:00.0       23     Event Processed:  Control
```

Item #	Event	Action	Description
1		Device Initialization	A joystick is required for the tracking task. If one is not detected, a dialog is displayed and the task is not shown.
2	3/15	Event Processed: Scheduling	Manual Tracking session started.
3	10/21	Event Processed : Scheduling	Manual Tracking session ends and automatic mode resumes.
4		Recording Interval Triggered: Tracking	For this run, the tracking task recording interval is 15 seconds. The event processed at a run time of “0:08.0” records for the first time at a time of 23.0” seconds.

File: ***TRCK_yyyy_mmddhhmm.txt*** entries

```
# Recording Interval is 15 seconds
#
#                                  THIS INTERVAL                                SESSION AGGREGATE
#-ELAPSED TIME  -SESSION TIME  -NUM  -SUM OF SQUARES  -RMSD-C        -NUM  -SUM OF SQUARES  -RMSD-C
#-------------------------------------------------------------------------------------------------
 00:00:23.0     00:15          276   21,994,041       282.292        276   21,994,041       282.292
 00:00:38.1     00:30          276   24,840,000       300.000        552   46,834,041       291.280
 00:01:25.0     00:15          276      155,876        23.765         276      155,876        23.765
 00:01:40.1     00:30          276      119,436        20.802         552      275,312        22.333

                RUN AGGREGATE
-NUM            -SUM OF SQUARES    -RMSD-C          -Remarks

  276           21,994,041         282.292          Begin: TU: HIGH, JR: MEDIUM
  552           46,834,041         291.280
  898           53,289,917         243.604          Begin: TU: MEDIUM, JR: HIGH
 1174           53,409,353         213.292
```

Sampling data is stored in three different sets of registers; the first is reset at the end of each interval, the second at the end of each session and the third is updated without resetting for the entire run. This allows different views of the subject's response.

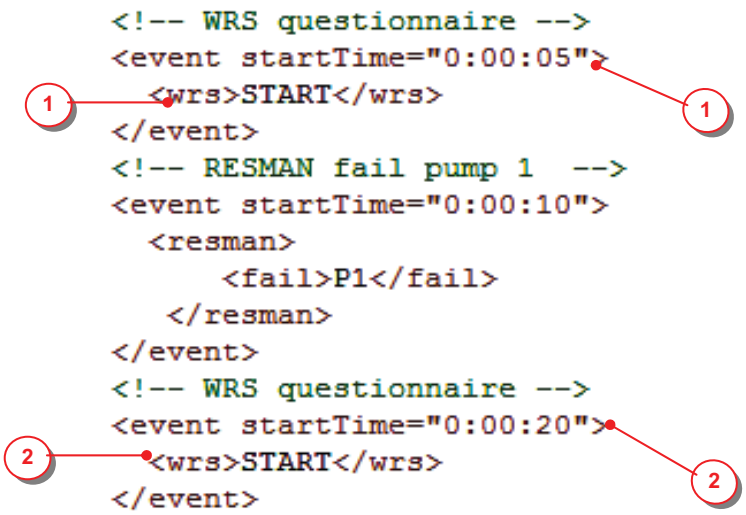
Item #	Action	Description
1	Elapsed Time	
2	Session Time	
3	Number of samples	The target position is sampled every 50 ms while in manual mode and recorded at 15 second intervals (the interval is configurable). Depending upon overall MATB activity the number of samples will vary slightly.
4	Sum Of Squares	Sum of Squares of each target position offset from the center.
5	RMSD-C	The Root Mean Square Deviation from the Center Point in Pixel Units. Compare the values for the second and seventh entry.
6	Remarks	Records the target update and joystick response fidelities for the session. Note that these are set for each session, so multiple combinations may be used during a single run.
7	Recording Interval	The recording interval is set in MATB_Config.xml

H Workload Rating Scale

The Workload Rating Scale (WRS) provides a method to obtain a subject's assessment of their workload during task performance. The Workload Rating questionnaire is launched by the appropriate entry in the task events file. While the rating scale is presented the run timer is paused. Active events in progress when the rating scale appears will not time out nor will any new events be processed until the timer is resumed. The rating scale used is based on the NASA Task Load Index (NASA TLX). The subscales are: Mental Demand, Physical Demand, Temporal Demand, Own Performance, Effort and Frustration. Each subscale has a slider for selecting a value. Once all the sliders have been moved the "Save All" becomes visible.

While the mouse is the primary way to respond to the WRS, the user may elect to use the arrow keys. The form opens with the focus on the first questions (i.e. Mental Demand). The right and left arrow keys are used to move the cursor. The up and down arrow keys move between the questions. Selecting the down arrow key from the last question (i.e. Frustration) moves the user to the "Save All" button, provided each of the sliders has been moved.

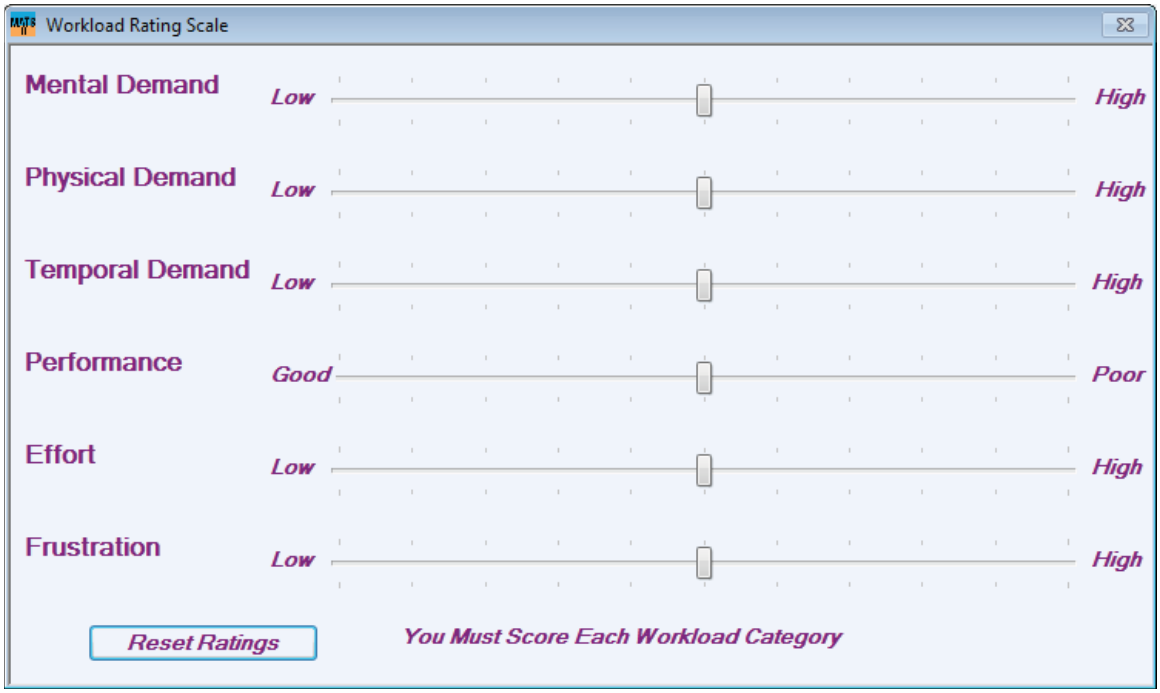
H.1 WRS Event to Launch the Questionnaire



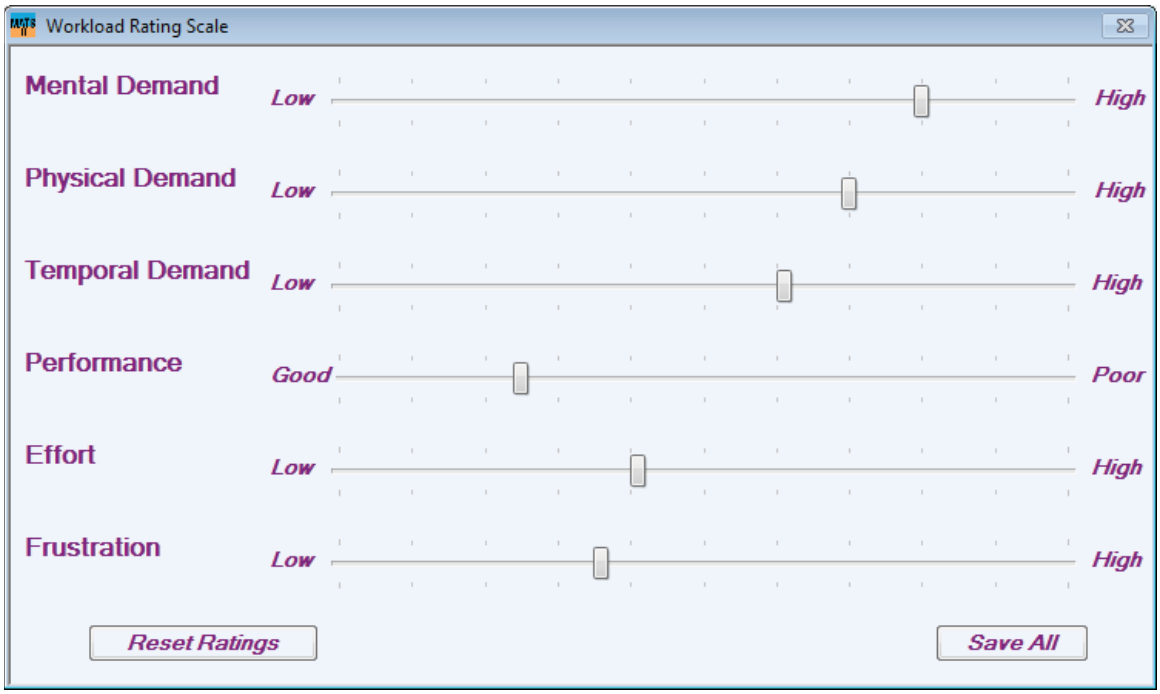
Sample events file entries that launch the Workload Rating Scale (WRS) questionnaire. The entry stops the elapsed timer and displays the WRS questionnaire.

Item #	Action	Description
1	<wrs> is the element key name	Elapsed timer is stopped and questionnaire displayed at a time of 0:00:05
2	<wrs> is the element key name	Elapsed timer is stopped and questionnaire displayed again at a time of 0:00:20

H.2 WRS Initial Display State

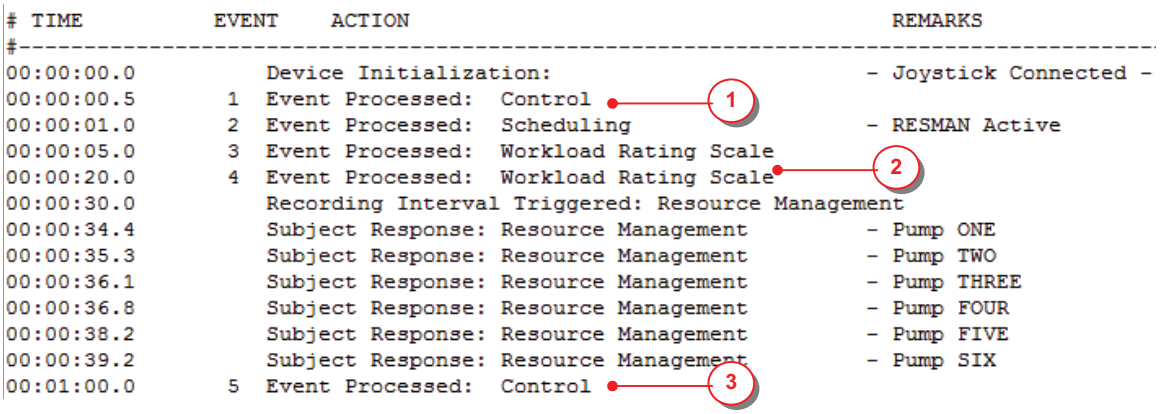


H.3 *WRS Completed Display State (Example)*



H.4 Output File Entries for WRS Events

File: ***MATB_yyyy_mmddhhmm.txt*** entries

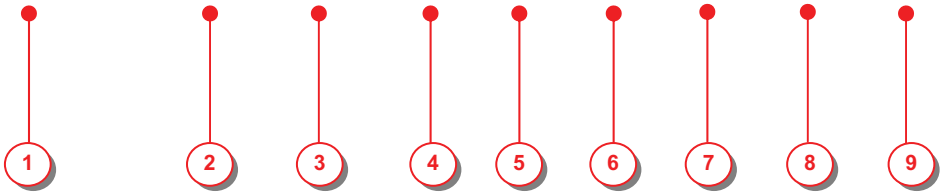


```
# TIME          EVENT    ACTION                                        REMARKS
#-------------------------------------------------------------------------------------
00:00:00.0          Device Initialization:                          - Joystick Connected -
00:00:00.5       1  Event Processed:  Control                    (1)
00:00:01.0       2  Event Processed:  Scheduling                 - RESMAN Active
00:00:05.0       3  Event Processed:  Workload Rating Scale
00:00:20.0       4  Event Processed:  Workload Rating Scale      (2)
00:00:30.0          Recording Interval Triggered: Resource Management
00:00:34.4          Subject Response: Resource Management        - Pump ONE
00:00:35.3          Subject Response: Resource Management        - Pump TWO
00:00:36.1          Subject Response: Resource Management        - Pump THREE
00:00:36.8          Subject Response: Resource Management        - Pump FOUR
00:00:38.2          Subject Response: Resource Management        - Pump FIVE
00:00:39.2          Subject Response: Resource Management        - Pump SIX
00:01:00.0       5  Event Processed:  Control                    (3)
```

Item #	Event	Action	Description
1	1	Control	Starts Run
2	3/4	Event Processed: Workload Rating Scale	Launches the WRS questionnaire
3	5	Control	Ends Run

File: ***WRS_yyyy_mmddhhmm.txt*** entries

```
#
#-TIME-NOW -TIME-    -MENL- -PHYS- -TEMP- -PERF- -EFFT- -FRUS- -MEAN-      -REMARKS-
#-------------------------------------------------------------------------------------
00:00:05.0  00:19.2   80     70     61     25     41     36     52.17
00:00:20.0  00:11.4   65     75     65     70     32     40     57.83
```



Item #	Action	Description
1	Elapsed Time	For the first instance the workload rating event was processed 14 seconds into the run.
2	Session Time	For the same instance the subject spent a little more than 23 seconds to complete the questionnaire.
3	MENL	The mental demand score
4	PHYS	The physical demand score
5	TEMP	The temporal demand score
6	PERF	Own performance score
7	EFFT	Effort score
8	FRUS	Frustration score
9	MEAN	The sum of the six scores divided by six.

I Recording Interval Output File Entries

At regular time intervals determined during configuration, MATB-II records output relating to processed events and subject responses. The entries are made for the RESMAN and TRACK task in their output files (i.e. TRCK_yyyy_mmddhhmm.txt and RMAN_yyyy-mmddhhmm.txt). In addition, an entry is made to MATB_yyyy_mmddhhmm.txt whenever one of these is triggered.

Note: See the “Recording Interval” subsection in the “MATB Configuration File” section for information on how to set these values.

I.1 Output File Entries for Joystick Device

The Tracking (**TRACK**) task requires a Universal Serial Bus (USB) joystick be attached to the computer. One of the MATB-II initialization steps is to poll the attached devices for the presence of a joystick. The first entry in every MATB_yyyy_mmddhhmm.txt is joystick status.
Note: As the TRACK task is not required for a valid run, the user may elect to continue without the use of a joystick.

File: ***MATB_yyyy_mmddhhmm.txt*** entries

```
# TIME          EVENT    ACTION                                          REMARKS
#-------------------------------------------------------------------------------------------
00:00:00.0          Device Initialization:                                - Joystick Connected -
```

Item #	Action	Description
1	Device Initialization	A USB joystick was found when the attached devices were polled.
2	Device Initialization	No USB joystick was found when the attached devices were polled.

```
# TIME          EVENT    ACTION                                          REMARKS
#-------------------------------------------------------------------------------------------
00:00:00.0          Device Initialization:                                - NO Joystick Connected -
```

I.2 Output File Entries for TRACK Task Interval Recordings

File: ***MATB_yyyy_mmddhhmm.txt*** entries

```
00:00:24.0          Recording Interval Triggered: Tracking
00:00:34.0          Recording Interval Triggered: Tracking
00:00:35.5          Subject Response: Resource Management          - Pump TWO
00:00:38.0          Subject Response: Resource Management          - Pump THREE
00:00:39.1          Subject Response: Resource Management          - Pump SEVEN
00:00:40.0          Recording Interval Triggered: Resource Management
00:00:42.0        7 Event Processed:  Resource Management         - Pump EIGHT Failed
00:00:44.1          Recording Interval Triggered: Tracking
00:00:51.0        8 Event Processed:  Communications              - NAV ONE OTHER Ship
00:00:54.0          Recording Interval Triggered: Tracking
00:00:56.0        9 Event Processed:  Scheduling                  - TRACK in Auto Mode
00:00:56.1          Subject Response: Resource Management         - Pump THREE
00:01:00.0          Recording Interval Triggered: Resource Management
00:01:02.0       10 Event Processed:  Resource Management         - Pump FOUR Fixed
00:01:04.0       11 Event Processed:  Scheduling                  - TRACK in Manual Mode
00:01:14.0          Recording Interval Triggered: Tracking
```

Item #	Action	Description
1	Recording Interval Triggered: Tracking	Second trigger for the first manual mode session of this run
2	Recording Interval Triggered: Tracking	First trigger for the second manual mode session of this run. Note that on the initial trigger the target update and joystick response rates are recorded in the remarks column.
3	Recording Interval: 15 seconds	Since this is a configurable item, the run value is recorded in the header of the TRACK task output file.

File: ***TRCK_yyyy_mmddhhmm.txt*** entries, shown in a figure that has been split in two parts.

```
# Recording Interval is 15 seconds
#
#                                    THIS INTERVAL                                SESSION AGGREGATE
#-ELAPSED TIME  -SESSION TIME  -NUM   -SUM OF SQUARES  -RMSD-C       -NUM   -SUM OF SQUARES  -RMSD-C
00:00:23.0       00:15          276   21,994,041       282.292       276    21,994,041       282.292
00:00:38.1       00:30          276   24,840,000       300.000       552    46,834,041       291.280
00:01:25.0       00:15          276      155,876        23.765       276       155,876        23.765
00:01:40.1       00:30          276      119,436        20.802       552       275,312        22.333
```

```
            RUN AGGREGATE
-NUM        -SUM OF SQUARES    -RMSD-C          -Remarks
-------------------------------------------------------------------------
  276          21,994,041      282.292          Begin: TU: HIGH, JR: MEDIUM
  552          46,834,041      291.280
  898          53,289,917      243.604          Begin: TU: MEDIUM, JR: HIGH
 1174          53,409,353      213.292
```

I.3 Output File Entries for RESMAN Task Interval Recordings

File: ***MATB_yyyy_mmddhhmm.txt*** entries

```
# Events Filename: MATB_EVENTS-2min-RecordingInterval.xml
# *** NOTE: Some entries deleted from original file ***
# TIME          EVENT    ACTION                                        REMARKS
#-------------------------------------------------------------------------------------------
00:00:00.0              Device Initialization:                        - Joystick Connected -
00:00:03.4              Subject Response: Resource Management         - Pump ONE
00:00:07.8              Subject Response: Resource Management         - Pump SIX
00:00:20.0              Recording Interval Triggered: Resource Management
00:00:39.1              Subject Response: Resource Management         - Pump SEVEN
00:00:40.0              Recording Interval Triggered: Resource Management
00:00:54.0              Recording Interval Triggered: Tracking
00:00:56.0        9     Event Processed:  Scheduling                  - TRACK in Auto Mode
00:00:56.1              Subject Response: Resource Management         - Pump THREE
00:01:00.0              Recording Interval Triggered: Resource Management
00:01:14.0              Recording Interval Triggered: Tracking
00:01:15.1              Subject Response: Resource Management         - Pump SEVEN
00:01:20.0              Recording Interval Triggered: Resource Management
00:01:34.1              Recording Interval Triggered: Tracking
00:01:34.6              Subject Response: Resource Management         - Pump THREE
00:01:40.0              Recording Interval Triggered: Resource Management
00:01:46.0              Subject Response: Resource Management         - Pump TWO
00:02:00.1              Recording Interval Triggered: Resource Management
00:02:00.5       16     Event Processed:  Control
```

Item #	Action	Description
1	Recording Interval: 20 seconds	Recording starts at 20 seconds into the run and continues at 20 second intervals thereafter. Since this is a configurable item, the run value is recorded in the header of the RESMAN task output file.
2	Recording Interval Triggered: Resource Management	The Action is recorded in MATB_yyyy_mmddhhmm.txt, with the tank volumes and differentials in RMAN_yyyy_mmddhhmm.txt.

File: ***RMAN_yyyy_mmddhhmm.txt*** entries

```
# Recording Interval is 20 seconds
# *** NOTE: Some header and subject responses deleted from original file ***
#
#-ELAPSED TIME   -PUMP # -PUMP ACTION -TANK UPDATE  -TANK A  -TANK B  -TANK C  -TANK D  -DIFF A  -DIFF B
#-------------------------------------------------------------------------------------------------------
 00:00:03.4        1        On            N             2461      2461      1000      1000       -39       -39
 00:00:07.8        6        On            N             2491      2455       958       974        -9       -45
 00:00:20.0                               Y             2611      2575       922       938       111        75
 00:00:39.1        7        On            N             2771      2582       862       891       271        82
 00:00:40.0                               Y             2771      2582       862       891       271        82
 00:00:56.1        3        On            N             2652      2480       811      1061       152       -20
 00:01:00.0                               Y             2631      2501       802      1052       131         1
 00:01:15.1        7        Off           N             2519      2613       754      1004        19       113
 00:01:20.0                               Y             2519      2613       742       992        19       113
 00:01:34.6        3        On            N             2519      2496       697      1064        19        -4
 00:01:40.0                               Y             2505      2510       682      1049         5        10
 00:01:46.0        2        Off           N             2528      2517       661      1028        28        17
```

I.4 Lost Focus and Run Paused Output File Entries

MATB-II records an entry whenever the run elapsed timer is stopped. There are two actions which cause the run elapsed timer to stop. One of the actions occurs when the user selects another application (e.g. a document or desktop shortcut, etc) and the other, when the user pauses the run with either the Menu -> Pause item or Ctrl-P key pair. The user can pause/resume MATB-II only when the AUTO_SELECT_MODE configuration key is "false". The entries are made once the run elapsed timer is restarted.

Note: For best performance, MATB-II should be the only application open during a data collection run, and the AUTO_SELECT_MODE configuration key is intended to be set to "true". During scenario development and subject training, it may be advantageous to have the User's Guide or other documents opened and minimized and / or AUTO_SELECT_MODE configuration key set to "false".

Item #	Action	Description
1	Information: MATB Lost The Focus	The time the focus was lost is recorded in the remarks column. In this instance it was for 7.4 seconds
2	Information: MATB Was Paused By The User	The time the run was paused is recorded in the remarks column. In this instance it was for 12.3 seconds

File: ***MATB_yyyy_mmddhhmm.txt*** entries

```
# Events Filename: MATB_EVENTS-2min-UG.xml
#
# TIME          EVENT    ACTION                                          REMARKS
#-------------------------------------------------------------------------------------------
00:00:00.0          Device Initialization:                               - Joystick Connected -
00:00:00.5       1  Event Processed:  Control
00:00:02.7       -  Information: MATB Lost The Focus For                 - 00:07.4 [min:sec.tenths]
00:00:07.0       2  Event Processed:  Scheduling                         - RESMAN and SYSMON Active
00:00:08.0       3  Event Processed:  Scheduling                         - TRACK in Manual Mode
00:00:09.0       4  Event Processed:  Resource Management                - Pump ONE Failed
00:00:10.5       5  Event Processed:  Scheduling                         - COMM Session Started
00:00:11.0       6  Event Processed:  System Monitoring                  - GREEN Light
00:00:12.9       -  Information: MATB Was Paused By The User For         - 00:12.3 [min:sec.tenths]
00:00:13.0          Recording Interval Triggered: Tracking
```

J Error and Warning Messages

MATB-II performs a number of checks and provides messages to the user when appropriate. They are intended as an aide during scenario development. “Warning” messages allow the run to continue, but MATB-II will shut down after an “Error” message is displayed. Neither “Error” nor “Warning” are appropriate during data collection runs.

MATB-II initialization requires a configuration file. The default filename is MATB_CONFIG.xml. If the file is not found in the XML subfolder, a message is shown and MATB will shut down.

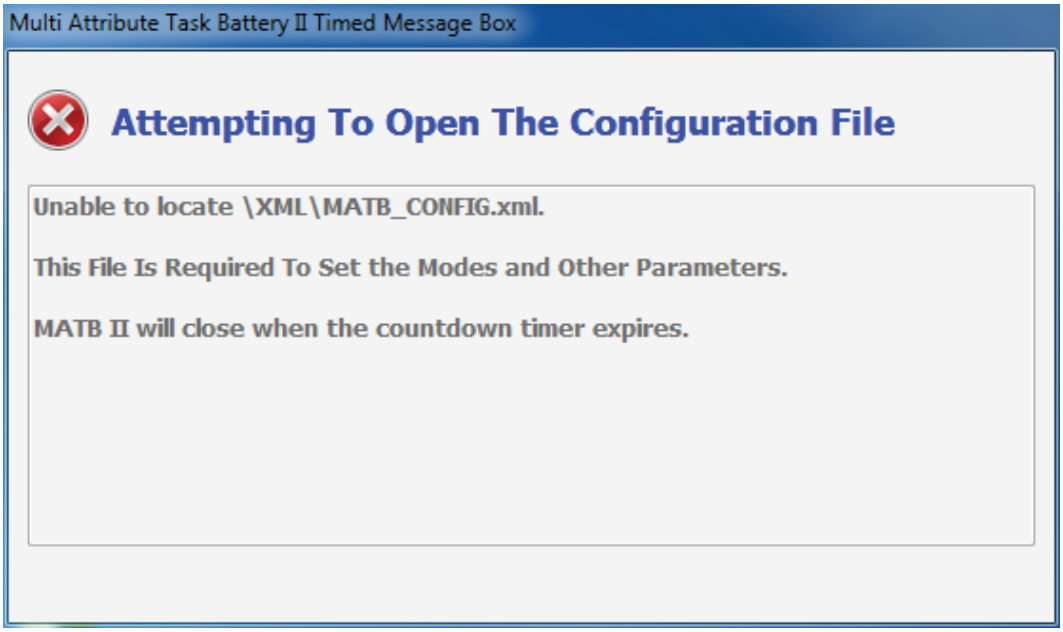
While a joystick must be installed to use the TRACK task, MATB may be used with only a subset of the available tasks. If a joystick is not found a message is displayed.

On startup, MATB reads the events file and creates a sequenced list. MATB allows multiple events to occur at the same time, but will reject an event with a time stamp earlier than the last one processed. If one is detected a message is displayed to the user.

The COMM and TRACK tasks are scheduled in “start” and “stop” sessions, which are visible on the Scheduling section of the display. “Start-Stop” event pairs are required to bracket each session. If one of these is missing a message is displayed and the desired session is not visible on the SCHEDULING display area.

The MATB installation media includes eight sets of 80 different audio files for use with the COMM task. These sets are in subfolders of the Audio directory named FEMALE_VOICE_SET_1, FEMALE_VOICE_ SET_2, MALE_VOICE_ SET_1, MALE_VOICE_ SET_2, MIXED_SET_1, MIXED_SET_2, MIXED_SET_3, and MIXED_SET_4. The first four folders contain the sound recordings of one individual and the other four are a mix of each of these sets. The MATB setup application (***SetupMATBII.msi***) installs the SET_1 files in the “\MATB\Audio” subfolder. These files are the utterances corresponding to the COMM events. If the sound recording corresponding to the COMM event is not found in the “\Audio” subfolder a message is displayed and the processed event ignored. The MATB run will continue.

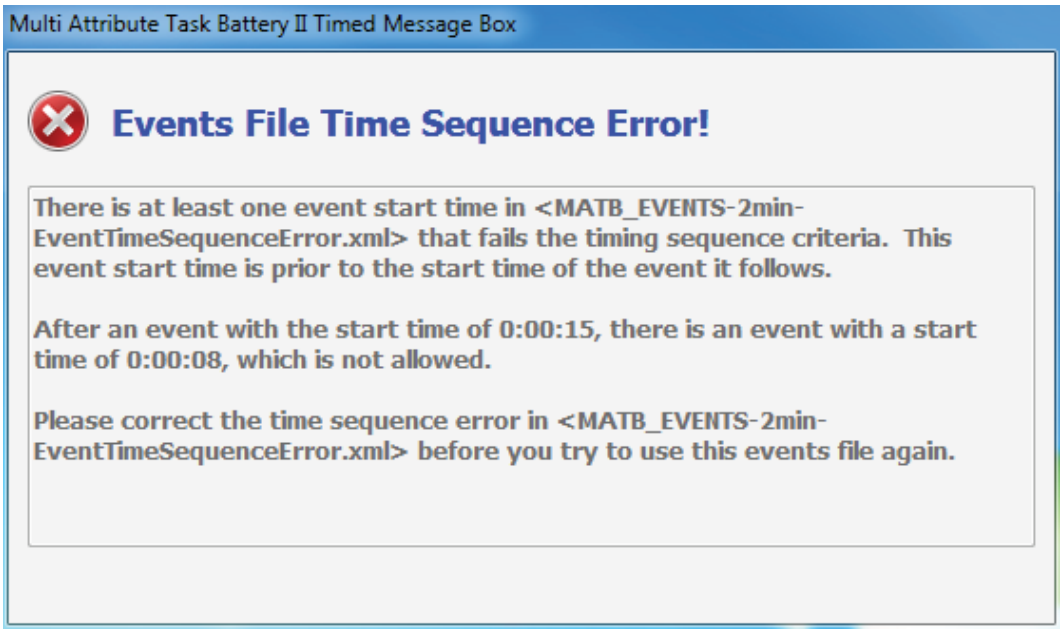
J.1 Error Message – Configuration File Not Found



If the configuration file is not found, MATB-II will shut down after a countdown timer expires. Make sure that MATB_CONFIG.xml is located in the XML subfolder. NOTE: Check that the file was not inadvertently saved without a file extension or with a ".txt" file extension instead of ".xml".

Note: Whenever MATB-II detects an error during initialization which prohibits normal operation, a timed message is displayed and MATB-II shuts down after the countdown timer expires. The error must be corrected to proceed past this point.

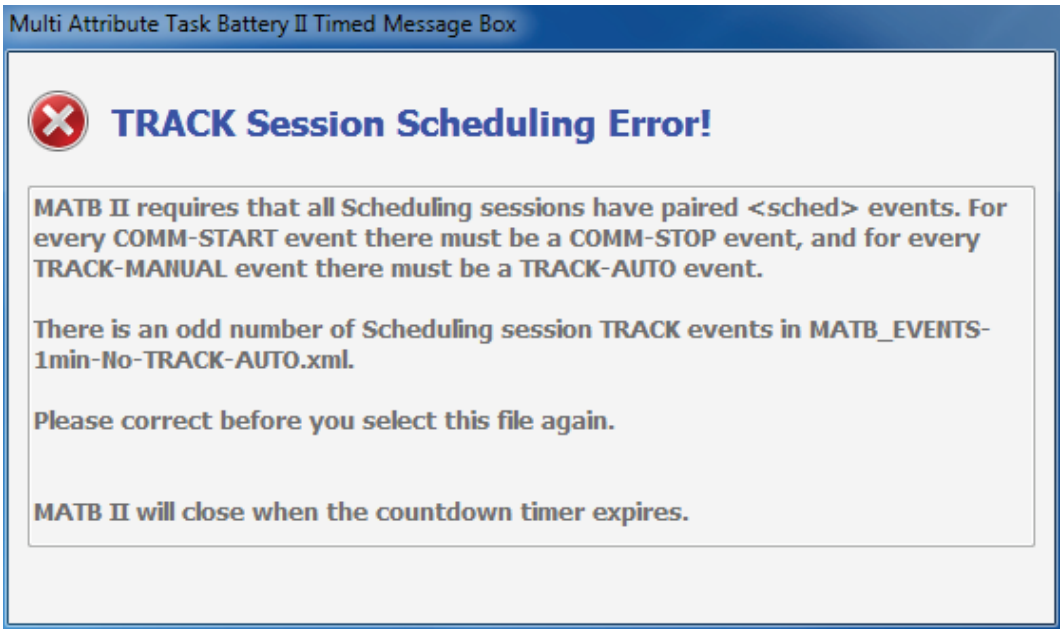
J.2 Error Message – Event Start Time Sequence Error



When the start time of an event is earlier than the start time of the event which precedes it, further checking stops and this message box is displayed. There may be additional time sequence issues, so when the correction is made all the start times should be checked.

Note: Whenever MATB-II detects an error during initialization which prohibits normal operation, a timed message is displayed box and then MATB-II shuts down after the countdown timer expires. The error must be corrected to proceed past this point.

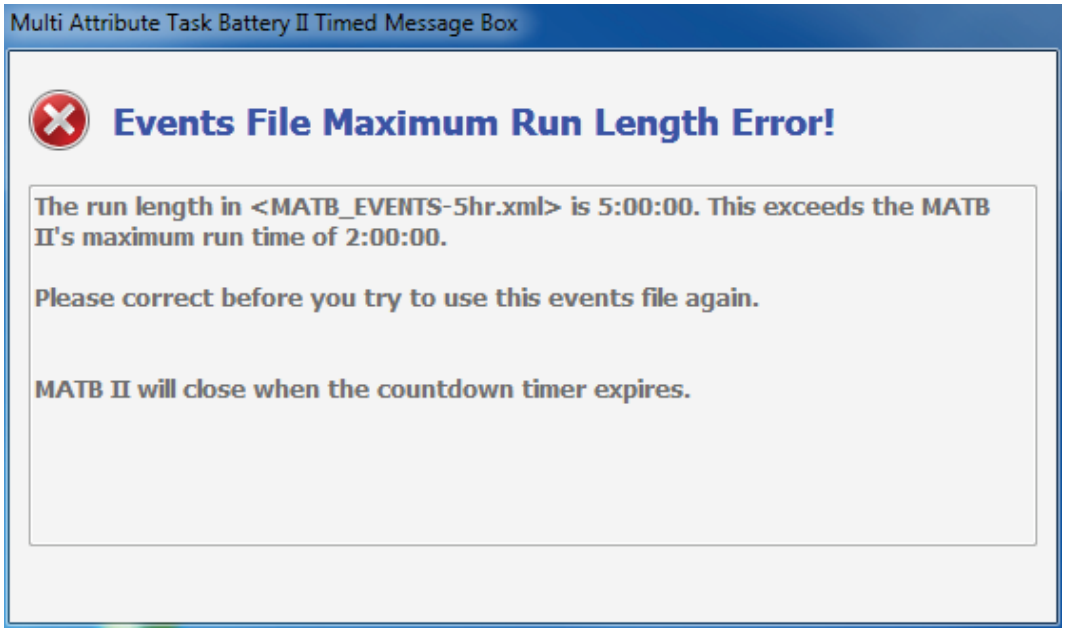
J.3 Error Message – Scheduling Pairs Errors



In order to be shown on the Scheduling "Look Ahead" window, COMM and TRACK sessions must be included in an events file. Both the COMM and TRACK sessions have "start" event, for which there must be and "stop" event.

Note: Whenever MATB-II detects an error during initialization which prohibits normal operation, a timed message is displayed box and then MATB-II shuts down after the countdown timer expires. The error must be corrected to proceed past this point.

J.4 Error Message – Maximum Run Length Exceeded



The maximum MATB-II run length is two hours. In this example, the time was entered as 5 hours. While the intent may have been to create a 5 or 50 minute run, MATB-II does not allows runs longer than two hours.

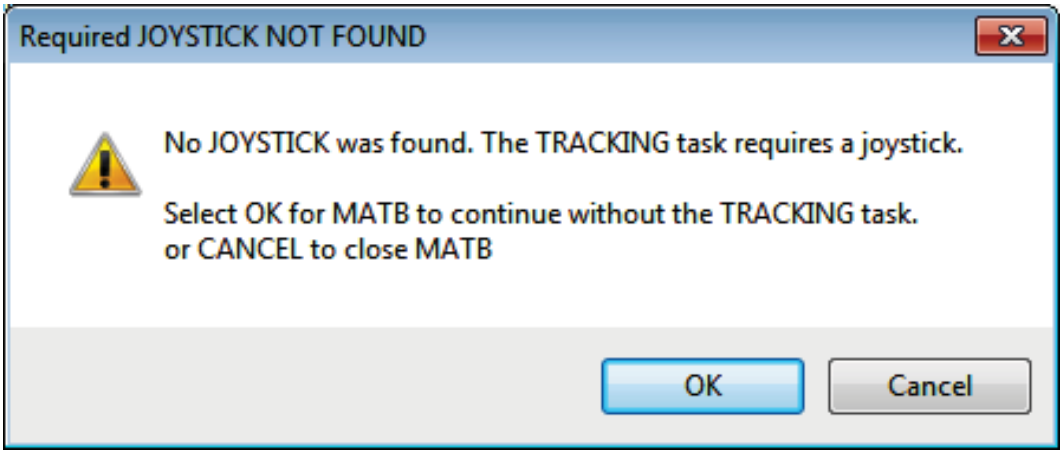
Note: Whenever MATB-II detects an error during initialization which prohibits normal operation, a timed message is displayed and then MATB-II shuts down after the countdown timer expires. The error must be corrected to proceed past this point.

J.5 Error Message – Required Control Event Missing

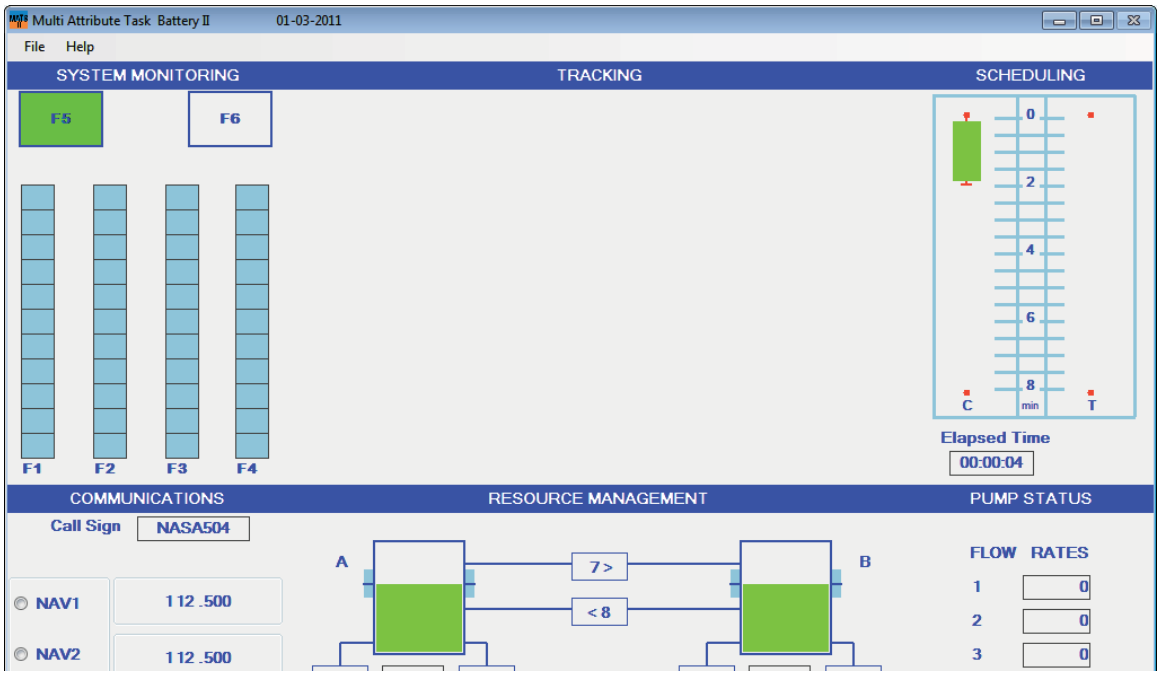
The first event MATB-II looks for is a control "START" event and the last must be a control "END" event. These set the boundaries between which MATB will check for events to process.

Note: Whenever MATB-II detects an error during initialization which prohibits normal operation, a timed message is displayed and then MATB-II shuts down after the countdown timer expires. The error must be corrected to proceed past this point.

J.6 Warning Message – No Joystick Found

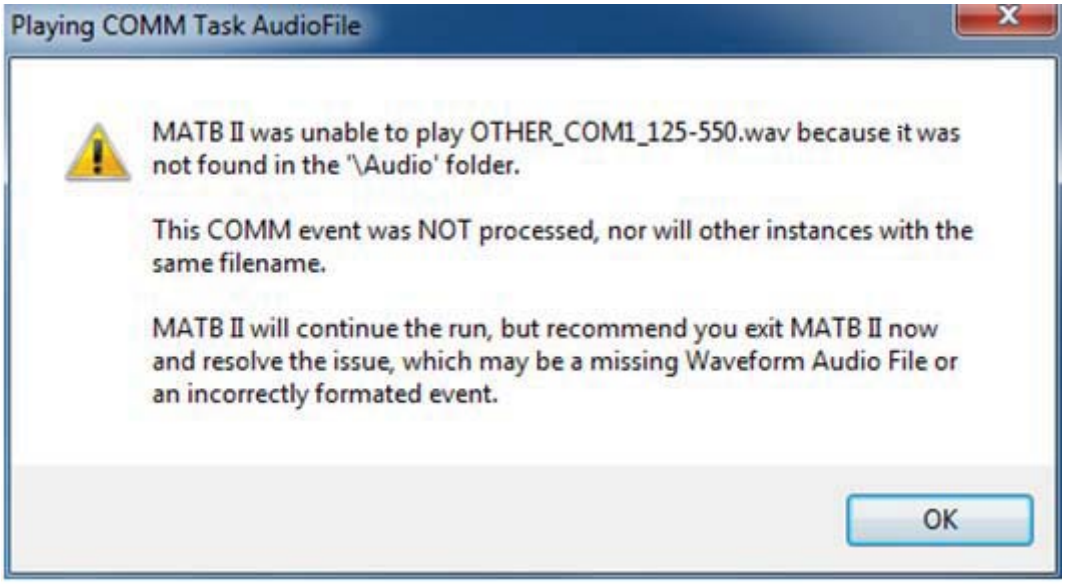


When the user selects "OK", MATB will continue, because there is no requirement that every task be included in a run. Selecting "Cancel" closes MATB. If the TRACK task is desired, ensure the joystick is properly connected.



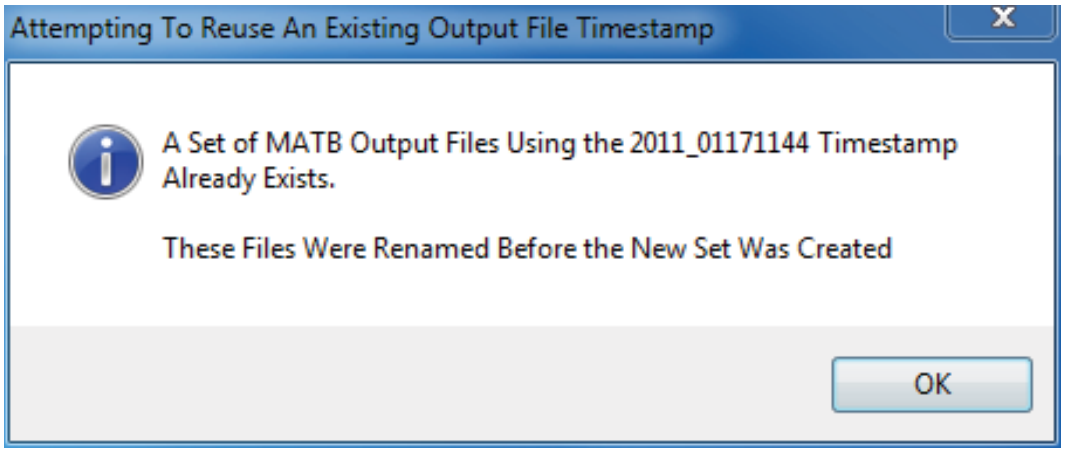
MATB will continue without the tracking task grid or text box visible.

J.7 Warning Message – COMM Audio File Not Found



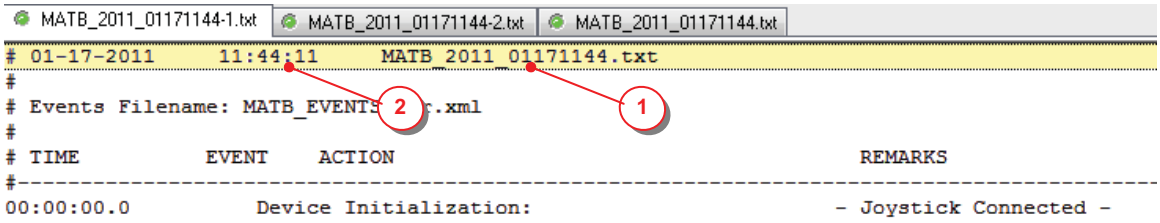
MATB-II will continue once the "OK" is selected. Valid COMM events will be processed, but both the contents of the Audio subfolder and the entries in the events file should be inspected before the file is used again.

J.8 Information Message – Timestamp Already Used



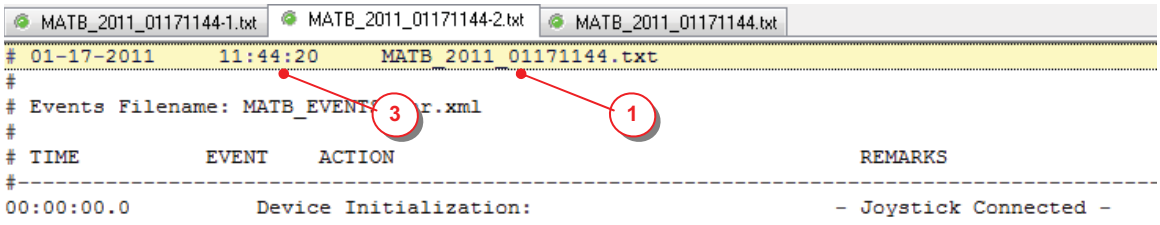
In addition to the information messages initiated from the menu, MATB displays a message when a set of output files with the same timestamp already exist. This state occurs if MATB is restarted within the same minute as the previous instance. While this is not a common occurrence, it may happen when MATB closes automatically due to an issue with the selected events file (see the error message examples above) and the user immediately restarts the application, perhaps using a different events file.
The previously existing files are renamed with a "-1" appended to the filename and the run continues once the "OK" is selected. The MATB master file is shown in the examples below, but the same process applies to all the output data files.

File: ***MATB_2011_01171144-1.txt***

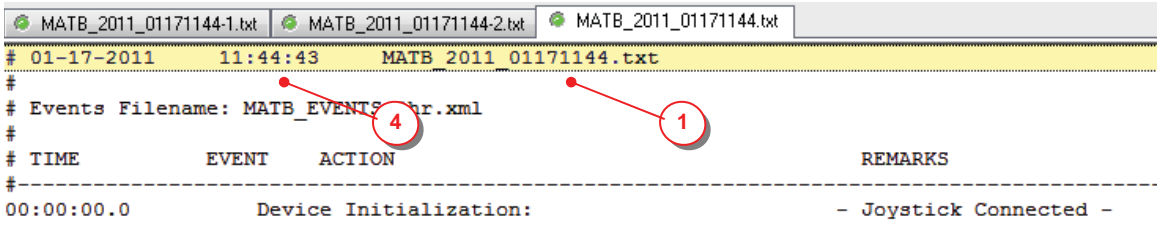


Item #	Action	Description
1	Timestamp	The timestamp used for all three files is **2011_01171144**
2	File creation time for the initial file	Time of 11:44:11. This file renamed to ***MATB_2011_01171144-1.txt*** when the second set is created.
3	File creation time for the second file (see next page)	Time of 11:44:20. This file renamed to ***MATB_2011_01171144-2.txt*** when the third set is created.
4	File creation time for the second file (see next page)	Time of 11:44:43. Filename is ***MATB_2011_01171144.txt***

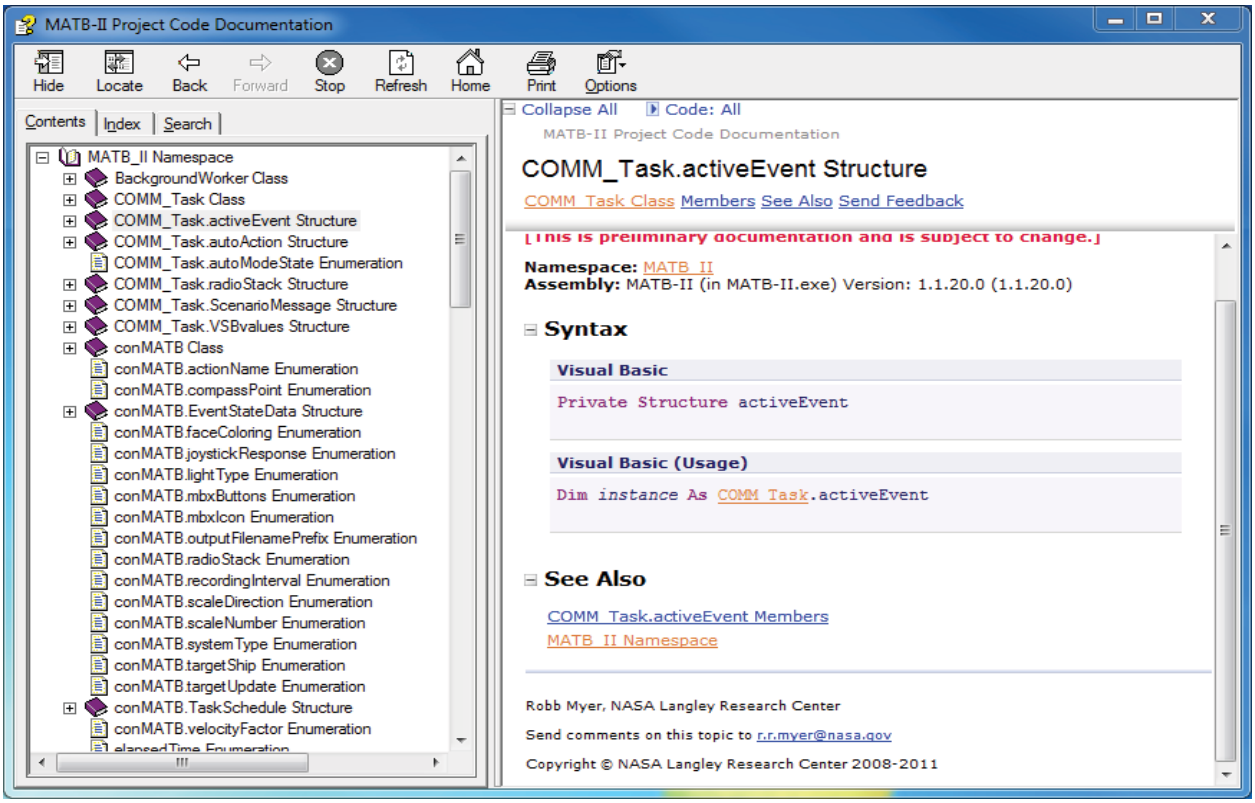
File: ***MATB_2011_01171144-2.txt***



File: ***MATB_2011_01171144.txt***



K MATB-II Microsoft Compiled HTML Help



MATB_Documentation.chm is Microsoft Compiled HTML Help File created with Sandcastle IntelliSense. It provides the user information about the syntax, methods, properties and remarks of the source code. ***MATB_Documentation.chm*** is located in the "\Help" subfolder. In testing mode it may also be launched by selecting the "?" from the title bar.

L User Guide for Creating Events Files

Through the generation of events, the researcher creates the experimental scenarios to which the subjects are going to respond to during a MATB-II session. Events are managed through entries in an Extensible Markup Language (XML) file. The purpose of this guide is to assist the experimenter to create these XML files. The MATB description, installation procedures, subject and experimenter interfaces, and audio file creation are covered in other sections of this document.

The naming convention for the events files is MATB_EVENTS-xxxx .xml, where "xxxx" is user defined. The name of the default events file is MATB_EVENTS.xml. The experimenter may either use the default name or add a dash (i.e. MATB_EVENTS-) and append an identifying string as a suffix. The experimenter can choose any suffix he/she desires, as long as this suffix doesn't contain any character usually reserved for the Operating System of the computer, such as "\". It is a good practice to select names that are meaningful to the experimenter to facilitate future retrieval; for example MATB_EVENTS-20min.xml is the events file for a run that lasts 20 minutes.

There are six different types of MATB events: four that correspond to the tasks the subject responds to (COMM, RESMAN, TRACK and SYSMON), WRS which asks for subject for feedback, and SCHED which provides visual cues to the current and look-ahead state of the COMM and TRACK tasks. Once started, the RESMAN and SYSMON tasks are always active unless explicitly stopped. In addition to the file entries that manage the events, there are additional entries that control the START and END of the run.

This guide consists of a number of tools to assist the experimenter in creating events files. The first is a series of worksheets to document the general information and a sequential listing of the events. Once a listing is created, the creator opens the appropriate templates in a text editor and can copy and paste the required entries into the events file. Any simple text editor (e.g. Notepad) will work, although it is best to use one that recognizes and highlights XML syntax. For this reason, the freeware Crimson Editor 3.70 is provided on the MATB distribution. Additionally a copy of Microsoft freeware XML Notepad 2007 is also provided on the MATB distribution. Those applications are useful for checking both the sequence and format of the events file when finally saved in the editor. While MATB performs some simple checks when it reads in the events file, only the creator knows the experiment objective. Refer to the Appendix for screen captures of Crimson Editor and XML Notepad 2007. Note that XML Notepad 2007requires .NET Framework 2.0 to be installed on the computer. If you intend to create events files on a different computer, install ".NET Framework 2.0" before you install XML Notepad 2007. A current version of the .NET Framework can be downloaded from http://msdn.microsoft.com.

L.1 Using Worksheets and Templates

A number of XML templates (*MATB_EVENTS-template-xxx.xml*) are provided with samples of the format used to control the events. They are provided so that the experimenter may copy the appropriate entries, paste them into their working file and then edit as needed. The creator should initially "save as" the *MATB_EVENTS-template-all.xml* file renamed as appropriate before making changes to the file. This is easily done by opening up all the templates of interest in Crimson Editor, although the effect is possible by copying the entries from one or more of the appendices in this document.

A worksheet is provided to assist the experimenter document at a high level the tasks desired to evaluate, their number of occurrences, and the duration of each run. A cross-reference between tasks and the applicable template is listed at the end of this appendix. Usually a run will include all of the tasks, but this is not required.

The worksheet is provided for listing and sequencing by start time all the events to be included in the events file. Sample entries for this worksheet are listed by task in the Appendix.

As previously noted, you can copy and paste directly from these appendices, although the recommended procedure is to open all the templates in Crimson Editor or the text editor of choice and then copy the desired entries and paste them in to the events file being created. Be sure to edit the entries as appropriate.

The Appendix also lists the names of the prerecorded audio files contained on the distribution media. Audio files must reside in the *MATB\Audio* subfolder for MATB to play them. Refer to the Appendix for the COMM task events file format.

L.2 Creating an Events File Step By Step

1) Print out a copy of the worksheet to document the sequence of the run.

2) Note which tasks will be used and the number of instances of each. Record the total duration of the run, as this is the first item you enter in the events file.

3) Open MATB_EVENTS-template-start.xml in the text editor (Crimson Editor or one of choice) and save with the appropriate name using the format MATB_EVENTS-xxxx.xml where the "xxxx" is an identifier assigned by the creator. This identifier should be unique for each events file, as it avoids duplication and can provide a special meaning to the creator. Refer to the Appendix for a screen capture of Crimson Editor with open events files and templates.

Using the completed event worksheet as a guide, copy each entry from the appropriate template file, paste in sequence in the new events file and edit the start time and tag values as needed.

Verify that the file is well-formed by opening it with XML Editor in Internet Explorer and view with Microsoft XML Notepad 2007 (XN07). When using XN07 you must expand the structure to see the child elements and their values. This is done from the menu bar by selecting *View > Expand All*. Refer to the Appendix for a screen capture of XN07 with the child elements expanded.

Copy the file to the *MATB\XML* subfolder, and test by running *MATB-II.exe.*
Note: In order to select events file with other than the default name of MATB_EVENTS.xml, the value of the <*SELECT_EVENTSFILE_MODE*> child element value must be "true" in the MATB_CONFIG.xml file. All the MATB_EVENTS-template-xxxx.xml files included with the distribution are valid files and may be used by MATB.

L.3 Experiment Worksheet

Experiment Name:				
Objective:				
Estimated time for each run:				
Number of runs per subject:				
Tasks included in this run and the desired number of each type of event.	COMM:	Y N	# COMM:	
	WRS:	Y N	# WRS:	
	RESMAN	Y N	# RESMAN:	
	SCHED:	Y N	# SCHED:	
	SYSMON:	Y N	# SYSMON:	
	TRACK:	Y N	# TRACK:	
Use the *Event Worksheet* to sequence the list of events				
All runs begin with *MATB_EVENTS-template-start.xml* saved with a unique name.				
The SCHED task is always included; refer to *MATB_EVENTS-template-sched.xml* for sample entries.				
If COMM task is included, refer to *MATB_EVENTS-template-comm.xml* for sample entries.				
If WRS task is included, refer to *MATB_EVENTS-template-start.xml* for a sample entry, Appendix L.10				
If RESMAN task is included, refer to *MATB_EVENTS-template-resman.xml* for sample entries.				
If SYSMON task is included, refer to *MATB_EVENTS-template-sysmon.xml* for sample entries.				
If TRACK task is included, refer to *MATB_EVENTS-template-track.xml for* sample entries.				

L.4 Events Worksheet

#	Start Time	Type	Attribute	Value

L.5 Sample Events Worksheet Entries for a COMM Event

#	Start Time	Type	Attribute	Value
1	0:02:20	COMM	<ship>	OTHER
			<radio>	COM1
			<freq>	
2	0:08:40	COMM	<ship>	OTHER
			<radio>	NAV2
			<freq>	
3	0:16:15	COMM	<ship>	OWN
			<radio>	COM2
			<freq>	
4	0:32:25	COMM	<ship>	OWN
			<radio>	NAV1
			<freq>	
		COMM	<ship>	
			<radio>	
			<freq>	

Use the last entry above as a template to populate the *Event Worksheet* and the others as samples. The MATB_AudioScriptsWithFilenames section provides guides and protocol to create additional audio scripts, the audio file naming convention and format to play these audio files in MATB-II. Refer to the MATB_AudioScriptsWithFilenames in Appendix Q.

L.6 Sample Events Worksheet Entries for a Workload Rating Scale (WRS) Event

#	Start Time	Type	Attribute	Value
1	0:04:15	WRS	<wrs>	START
2	0:12:20	WRS	<wrs>	START

At least one WRS event will be included in each run. An example for a WRS entry is shown in *MATB_EVENTS-template-start.xml*, Appendix L.10

L.7 Sample Events Worksheet Entries for a RESMAN Event

#	Start Time	Type	Attribute	Value
1	0:00:20	RESMAN	<fail>	P1
2	0:02:17	RESMAN	<fix>	P6

In the first example "pump one" is failed, and in the second "pump six" is fixed. While the pump is failed, it is not available to the subject. When it is fixed, it is available, but in the off state. Each of the eight pumps is controlled in the same manner.

The format for several entries is in *MATB_EVENTS-template-resman.xml*, Appendix L.12

L.8 Sample Events Worksheet Entries for a SCHED Event

#	Start Time	Type	Attribute	Value
1	0:01:00	SCHED	<task>	COMM
			<action>	START
			<update>	NULL
			<response>	NULL
2	0:06:30	SCHED	<task>	COMM
			<action>	STOP
			<update>	NULL
			<response>	NULL
3	0:02:15	SCHED	<task>	TRACK
			<action>	AUTO
			<update>	NULL
			<response>	NULL
4	0:05:45	SCHED	<task>	TRACK
			<action>	MANUAL
			<update>	MEDIUM
			<response>	LOW
5	0:00:05	SCHED	<task>	RESMAN
			<action>	START
			<update>	NULL
			<response>	NULL
6	0:00:10	SCHED	<task>	RESSYS
			<action>	START
			<update>	NULL
			<response>	NULL
7	0:00:15	SCHED	<task>	SYSMON
			<action>	START
			<update>	NULL
			<response>	NULL

The SCHED task visually shows the current state and a "look-ahead" for the COMM and TRACK task. While specific COMM audio files are activated by COMM entries, each TRACK session is started and stopped with SCHED. Normally, the RESMAN or SYSMON tasks (or RESSYS for both) are started and are active for the duration of the run.

The format for these entries is in *MATB_EVENTS-template-sched.xml*

L.9 Sample Events Worksheet Entries for a SYSMON Event

#	Start Time	Type	Attribute	Value
1	0:01:00	SYSMON	<monitoringLightType>	GREEN
2	0:01:30	SYSMON	<monitoringLightType>	RED
3	0:02:00	SYSMON	<monitoringScaleNumber>	ONE
			<monitoringScaleDirection>	UP
4	0:02:00	SYSMON	<monitoringScaleNumber>	ONE
			<monitoringScaleDirection>	DOWN
5	0:02:00	SYSMON	<monitoringScaleNumber>	TWO
			<monitoringScaleDirection>	UP
6	0:02:00	SYSMON	<monitoringScaleNumber>	TWO
			<monitoringScaleDirection>	DOWN
7	0:02:00	SYSMON	<monitoringScaleNumber>	THREE
			<monitoringScaleDirection>	UP
8	0:02:00	SYSMON	<monitoringScaleNumber>	THREE
			<monitoringScaleDirection>	DOWN
9	0:02:00	SYSMON	<monitoringScaleNumber>	FOUR
			<monitoringScaleDirection>	UP
10	0:02:00	SYSMON	<monitoringScaleNumber>	FOUR
			<monitoringScaleDirection>	DOWN

The SYSMON task changes the state of lights and scales.

The format for these entries is in *MATB_EVENTS-template-sysmon.xml*

L.10 MATB_EVENTS-template-start.xml

```
?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- Start Template File -->
<!-- Created on 03-02-2009 -->
<!-- Contains the template to save as the initial file -->
<!-- and then copy / paste /edit entries from other template files -->
<!-- Since most runs will have at least one WRS event, it's template is included -->
<MATB-EVENTS>
<!-- Start MATB Timer -->
<event startTime="0:00:00">
        <control>START</control>
</event>
<!-- Workload Rating -->
<event startTime="0:01:00">
        <wrs>START</wrs>
</event>
<!-- Stop MATB Timer and end experiment -->
<event startTime="0:02:00">
        <control>END</control>
</event>
</MATB-EVENTS>
```

L.11 MATB_EVENTS-template-comm.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- COMM Task Template File -->
<!-- Created on 03-02-2009 -->
<!-- Contains the templates to copy / paste /edit for the COMM task  -->
<!-- Includes the START / STOP control tags and COMM entries for the SCHED task -->
<!-- The startTime= attribute and freq tag values will have to be edited -->
<!-- 112.500 and 126.500 are the mid-frequencies for the NAV and COM radios -->
<MATB-EVENTS>
<!-- Start MATB Timer -->
<event startTime="0:00:00">
            <control>START</control>
</event>
<!-- Sched task: COMM START -->
<event startTime="0:00:05">
  <sched>
    <task>COMM</task>
    <action>START</action>
    <update>NULL</update>
    <response>NULL</response>
  </sched>
</event>
<!-- To play the OTHER_COM1_126-500.wav -->
<event startTime="0:00:30">
  <comm>
    <ship>OTHER</ship>
    <radio>COM1</radio>
    <freq>126.500</freq>
  </comm>
</event>
<!-- To play the OTHER_COM2_126-500.wav -->
<event startTime="0:01:00">
 <comm>
    <ship>OTHER</ship>
    <radio>COM2</radio>
    <freq>126.500</freq>
  </comm>
</event>
<!-- To play the OTHER_NAV1_112-500.wav -->
<event startTime="0:01:30">
 <comm>
    <ship>OTHER</ship>
    <radio>NAV1</radio>
    <freq>112.500</freq>
  </comm>
</event>
```

```
<!-- To play the OTHER_NAV2_112-500.wav -->
<event startTime="0:02:00">
 <comm>
    <ship>OTHER</ship>
    <radio>NAV2</radio>
    <freq>112.500</freq>
  </comm>
</event>
<!-- To play the OWN_COM1_126-500.wav -->
<event startTime="0:02:30">
 <comm>
    <ship>OWN</ship>
    <radio>COM1</radio>
    <freq>126.500</freq>
  </comm>
</event>
<!-- To play the OWN_COM2_126-500.wav -->
<event startTime="0:03:00">
 <comm>
    <ship>OWN</ship>
    <radio>COM2</radio>
    <freq>126.500</freq>
  </comm>
</event>
<!-- To play the OWN_NAV1_112-500.wav -->
<event startTime="0:03:30">
 <comm>
    <ship>OWN</ship>
    <radio>NAV1</radio>
    <freq>112.500</freq>
  </comm>
</event>
<!-- To play the OWN_NAV2_112-500.wav -->
<event startTime="0:04:00">
 <comm>
    <ship>OWN</ship>
    <radio>NAV2</radio>
    <freq>112.500</freq>
  </comm>
</event>
<!-- Sched task: COMM STOP -->
<event startTime="0:04:30">
   <sched>
    <task>COMM</task>
    <action>STOP</action>
    <update>NULL</update>
    <response>NULL</response>
  </sched>
</event>

<!-- Stop MATB Timer and end experiment -->
<event startTime="0:05:00">
            <control>END</control>
</event>
</MATB-EVENTS>
```

L.12 MATB_EVENTS-template-resman.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- RESMAN Task Template File -->
<!-- Created on 03-03-2009 -->
<!-- Contains the templates for copy / paste /edit for the RESMAN task  -->
<!-- Includes the START / STOP control tags and RESMAN entries for the SCHED task -->
<!-- The startTime= attribute and pump number tag values will have to be edited -->
<!-- If both RESMAN and SYSMON task are active a single SCHED event will activate both -->
<MATB-EVENTS>
<!-- Start MATB Timer -->
<event startTime="0:00:00">
  <control>START</control>
</event>
<!-- Start both Resource Management and System Monitoring tasks  -->
<event startTime="0:00:01">
  <sched>
     <task>RESSYS</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<!-- Start Resource Management task  -->
<event startTime="0:00:02">
  <sched>
     <task>RESMAN</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<!-- Fail pump 1  -->
<event startTime="0:01:00">
  <resman>
     <fail>P1</fail>
   </resman>
</event>
<!-- Fix pump 1  -->
<event startTime="0:01:30">
  <resman>
     <fix>P1</fix>
  </resman>
</event>
```

```
<!-- Fail pump 2  -->
<event startTime="0:02:00">
            <resman>
     <fail>P2</fail>
  </resman>
</event>
<!-- Fix pump 2  -->
<event startTime="0:02:30">
  <resman>
     <fix>P2</fix>
  </resman>
</event>
<!-- Fail pump 3  -->
<event startTime="0:03:00">
  <resman>
     <fail>P3</fail>
   </resman>
</event>
<!-- Fix pump 3  -->
<event startTime="0:03:30">
  <resman>
     <fix>P3</fix>
  </resman>
</event>
<!-- Fail pump 4  -->
<event startTime="0:04:00">
  <resman>
     <fail>P4</fail>
  </resman>
</event>
<!-- Fix pump 4  -->
<event startTime="0:04:30">
  <resman>
     <fix>P4</fix>
  </resman>
</event>
<!-- Fail pump 5  -->
<event startTime="0:05:00">
  <resman>
     <fail>P5</fail>
   </resman>
</event>
<!-- Fix pump 5  -->
<event startTime="0:05:30">
  <resman>
     <fix>P5</fix>
  </resman>
</event>
<!-- Fail pump 6  -->
<event startTime="0:06:00">
  <resman>
     <fail>P6</fail>
  </resman>
</event>
```

```
<!-- Fix pump 6  -->
<event startTime="0:06:30">
  <resman>
     <fix>P6</fix>
  </resman>
</event>
<!-- Fail pump 7  -->
<event startTime="0:07:00">
  <resman>
     <fail>P7</fail>
   </resman>
</event>
<!-- Fix pump 7  -->
<event startTime="0:07:30">
  <resman>
     <fix>P7</fix>
  </resman>
</event>
<!-- Fail pump 8  -->
<event startTime="0:08:00">
  <resman>
     <fail>P8</fail>
  </resman>
</event>
<!-- Fix pump 8  -->
<event startTime="0:08:30">
  <resman>
     <fix>P8</fix>
  </resman>
</event>
<!-- Stop MATB Timer and end experiment -->
<event startTime="0:09:00">
  <control>END</control>
</event>
</MATB-EVENTS>
```

L.13 MATB_EVENTS-template-sched.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- SCHED Template File -->
<!-- Created on 03-03-2009 -->
<!-- Contains the templates to  copy / paste /edit SCHED entries -->
<!-- TRACK target update rate values: LOW, MEDIUM, HIGH -->
<!-- TRACK joystick response values: LOW, MEDIUM, HIGH -->
<MATB-EVENTS>
<event startTime="0:00:00">
<!-- Start MATB Timer -->
  <control>START</control>
</event>
<event startTime="0:01:00">
<!-- Start Communications task  -->
  <sched>
     <task>COMM</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:03:00">
 <!-- Stop Communications task   -->
    <sched >
     <task>COMM</task>
     <action>STOP</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:03:11">
<!-- Start Resource Management task  -->
  <sched>
     <task>RESMAN</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>

<event startTime="0:03:21">
<!-- Start Resource Management and System Monitoring tasks  -->
  <sched>
     <task>RESSYS</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:03:31">
<!-- Start System Monitoring task  -->
  <sched>
     <task>SYSMON</task>
```

```
    <action>START</action>
    <update>NULL</update>
    <response>NULL</response>
  </sched>
</event>
<event startTime="0:04:05">
<!-- Start Tracking task: Edit update and response as required -->
  <sched>
    <task>TRACK</task>
    <action>MANUAL</action>
    <update>MEDIUM</update>
    <response>MEDIUM</response>
  </sched>
</event>
<event startTime="0:04:35">
<!-- Stop Tracking task -->
  <sched >
    <task>TRACK</task>
    <action>AUTO</action>
    <update>NULL</update>
    <response>NULL</response>
  </sched>
</event>
<event startTime="0:05:00">
<!-- Stop MATB Timer and end experiment -->
  <control>END</control>
</event>
</MATB-EVENTS>
```

L.14 MATB_EVENTS-template-sysmon.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- SYSMON Template File -->
<!-- Created on 03-03-2009 -->
<!-- Contains the templates to  copy / paste /edit SYSMON entries -->
<!-- If both RESMAN and SYSMON task are active a single SCHED event will activate both -->
<MATB-EVENTS>
<event startTime="0:00:00">
<!-- Start MATB Timer -->
  <control>START</control>
</event>
<event startTime="0:00:01">
<!-- Start Resource Management and System Monitoring tasks  -->
  <sched>
     <task>RESSYS</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:00:02">
<!-- Start System Monitoring task  -->
  <sched>
     <task>SYSMON</task>
     <action>START</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:00:13">
<!-- Turn The GREEN light, Normally ON to OFF -->
  <sysmon>
     <monitoringLightType>GREEN</monitoringLightType>
   </sysmon>
</event>
<event startTime="0:00:23">
<!-- Turn The RED light, Normally OFF to ON -->
  <sysmon>
     <monitoringLightType>RED</monitoringLightType>
   </sysmon>
</event>
<event startTime="0:00:33">
<!-- Move SCALE ONE DOWN -->
  <sysmon>
     <monitoringScaleNumber>ONE</monitoringScaleNumber>
     <monitoringScaleDirection>DOWN</monitoringScaleDirection>
   </sysmon>
</event>
```

```
<event startTime="0:00:43">
<!-- Move SCALE ONE UP -->
 <sysmon>
    <monitoringScaleNumber>ONE</monitoringScaleNumber>
    <monitoringScaleDirection>UP</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:00:53">
<!-- Move SCALE TWO DOWN -->
 <sysmon>
    <monitoringScaleNumber>TWO</monitoringScaleNumber>
    <monitoringScaleDirection>DOWN</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:01:03">
<!-- Move SCALE TWO UP -->
 <sysmon>
    <monitoringScaleNumber>TWO</monitoringScaleNumber>
    <monitoringScaleDirection>UP</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:01:13">
<!-- Move SCALE THREE DOWN -->
 <sysmon>
    <monitoringScaleNumber>THREE</monitoringScaleNumber>
    <monitoringScaleDirection>DOWN</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:01:23">
<!-- Move SCALE THREE UP -->
 <sysmon>
    <monitoringScaleNumber>THREE</monitoringScaleNumber>
    <monitoringScaleDirection>UP</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:01:33">
<!-- Move SCALE FOUR DOWN -->
 <sysmon>
    <monitoringScaleNumber>FOUR</monitoringScaleNumber>
    <monitoringScaleDirection>DOWN</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:01:43">
<!-- Move SCALE FOUR UP -->
 <sysmon>
    <monitoringScaleNumber>FOUR</monitoringScaleNumber>
    <monitoringScaleDirection>UP</monitoringScaleDirection>
  </sysmon>
</event>
<event startTime="0:02:00">
<!-- Stop MATB Timer and end experiment -->
 <control>END</control>
</event>
</MATB-EVENTS>
```

L.15 MATB_EVENTS-template-track.xml

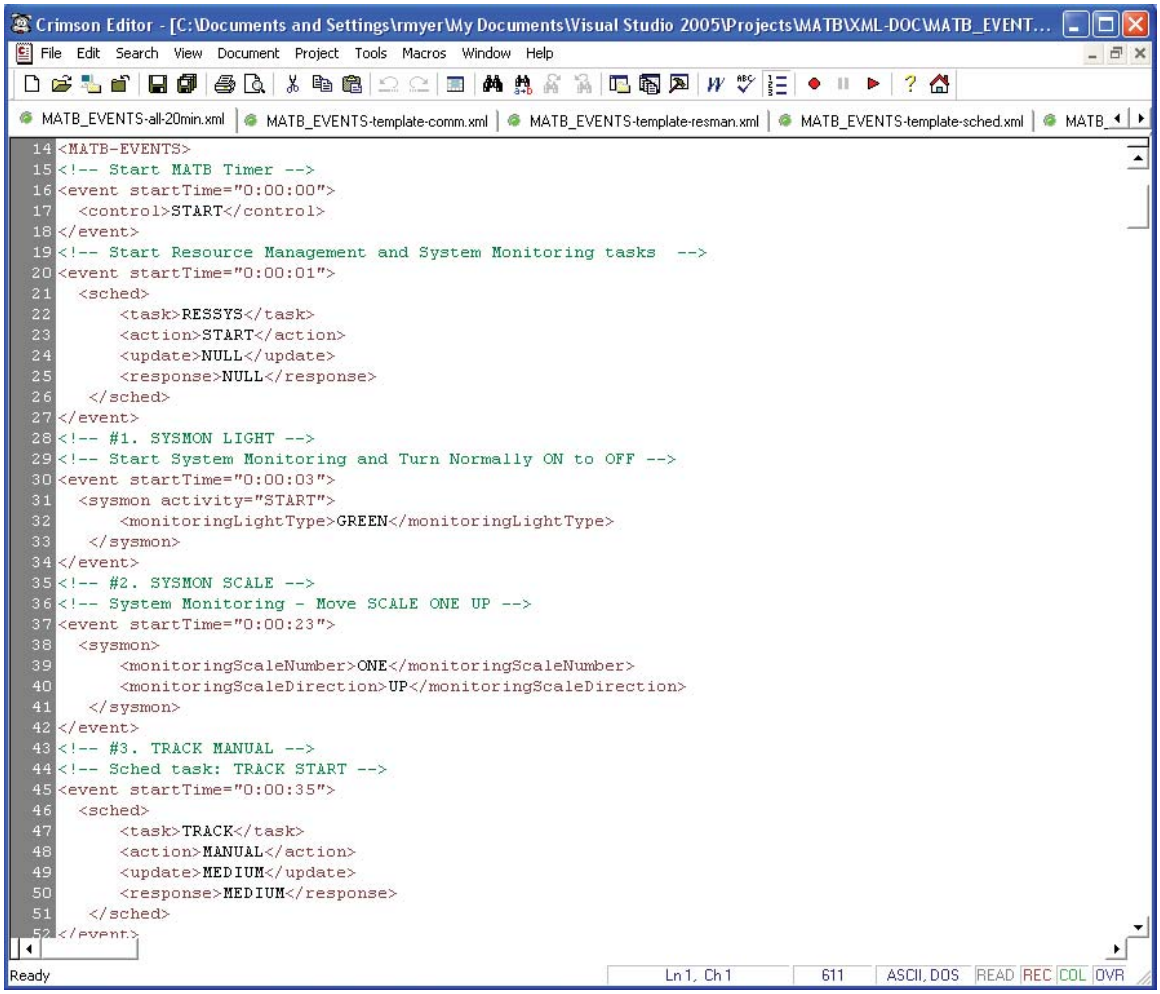
```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- Multi-Attribute Task Battery Events -->
<!-- Start Template File -->
<!-- Created on 03-03-2009 -->
<!-- Contains the templates for  copy / paste /edit TRACK entries -->
<!-- TRACK target update rate values: LOW, MEDIUM, HIGH -->
<!-- TRACK joystick response values: LOW, MEDIUM, HIGH -->
<!-- The TRACK task is controlled through SCHED entries -->
<MATB-EVENTS>
<event startTime="0:00:00">
<!-- Start MATB Timer -->
  <control>START</control>
</event>
<event startTime="0:00:05">
<!-- Start Tracking task: Edit update and response as required -->
  <sched>
     <task>TRACK</task>
     <action>MANUAL</action>
     <update>MEDIUM</update>
     <response>MEDIUM</response>
   </sched>
</event>
<event startTime="0:01:55">
<!-- Stop Tracking task -->
  <sched >
     <task>TRACK</task>
     <action>AUTO</action>
     <update>NULL</update>
     <response>NULL</response>
   </sched>
</event>
<event startTime="0:02:00">
<!-- Stop MATB Timer and end experiment -->
  <control>END</control>
</event>
</MATB-EVENTS>
```

M COMM Audio Filenames

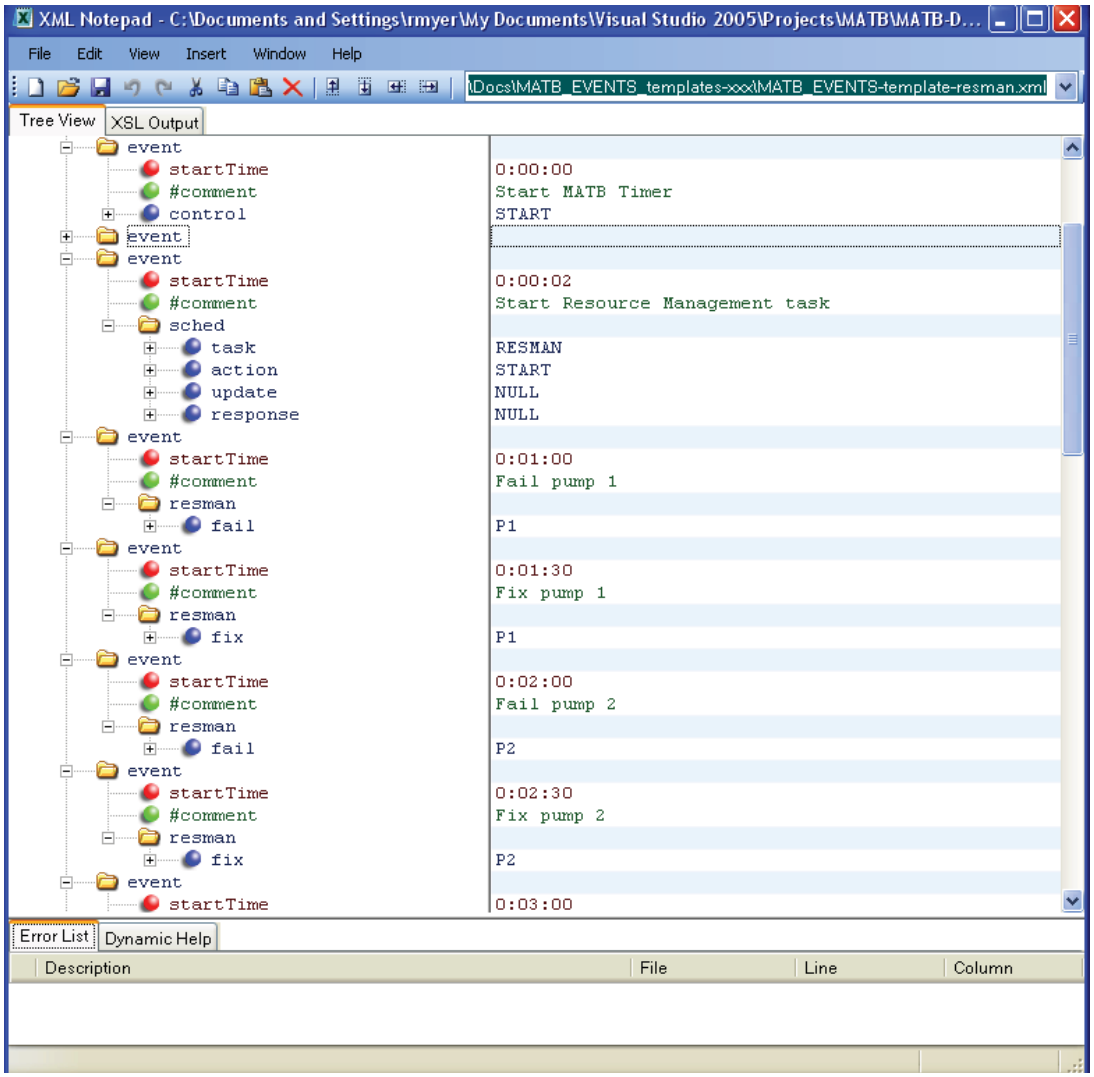
#	Audio Filename
1	OWN_COM1_124-575.wav
2	OWN_COM1_125-550.wav
3	OWN_COM1_126-525.wav
4	OWN_COM1_127-500.wav
5	OWN_COM1_128-475.wav
6	OWN_COM1_129-450.wav
7	OWN_COM1_128-575.wav
8	OWN_COM1_127-550.wav
9	OWN_COM1_126-450.wav
10	OWN_COM1_125-500.wav
11	OWN_COM2_129-575.wav
12	OWN_COM2_128-550.wav
13	OWN_COM2_127-525.wav
14	OWN_COM2_126-475.wav
15	OWN_COM2_125-500.wav
16	OWN_COM2_124-450.wav
17	OWN_COM2_125-575.wav
18	OWN_COM2_126-550.wav
19	OWN_COM2_127-500.wav
20	OWN_COM2_128-525.wav
21	OWN_NAV1_110-650.wav
22	OWN_NAV1_111-600.wav
23	OWN_NAV1_112-550.wav
24	OWN_NAV1_113-500.wav
25	OWN_NAV1_114-450.wav
26	OWN_NAV1_115-400.wav
27	OWN_NAV1_114-650.wav
28	OWN_NAV1_113-600.wav
29	OWN_NAV1_112-450.wav
30	OWN_NAV1_111-500.wav
31	OWN_NAV2_115-650.wav
32	OWN_ NAV2_114-600.wav
33	OWN_ NAV2_113-550.wav
34	OWN_ NAV2_112-450.wav
35	OWN_ NAV2_111-400.wav
36	OWN_ NAV2_110-500.wav
37	OWN_ NAV2_111-650.wav
38	OWN_ NAV2_112-600.wav
39	OWN_ NAV2_113-500.wav
40	OWN_ NAV2_114-450.wav

#	**Audio Filename**
41	OTHER_COM1_118-325.wav
42	OTHER_COM1_120-825.wav
43	OTHER_COM1_124-350.wav
44	OTHER_COM1_126-175.wav
45	OTHER_COM1_127-725.wav
46	OTHER_COM1_128-525.wav
47	OTHER_COM1_130-875.wav
48	OTHER_COM1_132-950.wav
49	OTHER_COM1_134-175.wav
50	OTHER_COM1_135-225.wav
51	OTHER_COM2_118-275.wav
52	OTHER_COM2_120-775.wav
53	OTHER_COM2_124-500.wav
54	OTHER_COM2_126-025.wav
55	OTHER_COM2_127-675.wav
56	OTHER_COM2_128-475.wav
57	OTHER_COM2_130-725.wav
58	OTHER_COM2_132-800.wav
59	OTHER_COM2_134-025.wav
60	OTHER_COM2_135-175.wav
61	OTHER_NAV1_108-350.wav
62	OTHER_NAV1_109-250.wav
63	OTHER_NAV1_110-400.wav
64	OTHER_NAV1_111-950.wav
65	OTHER_NAV1_112-150.wav
66	OTHER_NAV1_113-000.wav
67	OTHER_NAV1_114-500.wav
68	OTHER_NAV1_115-750.wav
69	OTHER_NAV1_116-450.wav
70	OTHER_NAV1_117-650.wav
71	OTHER_NAV2_108-750.wav
72	OTHER_NAV2_109-650.wav
73	OTHER_NAV2_110-800.wav
74	OTHER_NAV2_111-350.wav
75	OTHER_NAV2_112-550.wav
76	OTHER_NAV2_113-400.wav
77	OTHER_NAV2_114-900.wav
78	OTHER_NAV2_115-050.wav
79	OTHER_NAV2_116-850.wav
80	OTHER_NAV2_117-950.wav

N Crimson Editor Screen Capture of a MATB_EVENTS File



N.1 XML Notepad 2007 Screen Capture of a MATB_EVENTS File



O A complete MATB_II_*.txt output file for a 5 minute run

02-11-2011 20:42:14 MATB_2011_02112041.txt
#
Events Filename: MATB_EVENTS-5min-Rating.xml

TIME	EVENT	ACTION	REMARKS
00:00:00.0		Device Initialization:	- Joystick Connected -
00:00:17.0	1	Event Processed: Control	
00:00:17.5	2	Event Processed: Scheduling	- RESMAN and SYSMON Active
00:00:18.0	3	Event Processed: Scheduling	- TRACK in Manual Mode
00:00:18.5	4	Event Processed: Resource Management	- Pump ONE Failed
00:00:19.0	5	Event Processed: System Monitoring	- GREEN Light
00:00:19.3		Subject Response: Resource Management	- Pump TWO
00:00:20.1		Subject Response: System Monitoring	- GREEN Light
00:00:21.2		Subject Response: Resource Management	- Pump FOUR
00:00:22.2		Subject Response: Resource Management	- Pump THREE
00:00:22.6		Subject Response: Resource Management	- Pump SIX
00:00:23.5		Subject Response: Resource Management	- Pump FIVE
00:00:30.0		Recording Interval Triggered: Resource Management	
00:00:33.1		Recording Interval Triggered: Tracking	
00:00:34.0	6	Event Processed: Scheduling	- COMM Session Started
00:00:35.0	7	Event Processed: Resource Management	- Pump ONE Fixed
00:00:40.0	8	Event Processed: Communications	- COM ONE OWN Ship
00:00:40.0		Event Terminated: Communications	
00:00:45.0	9	Event Processed: Resource Management	- Pump FIVE Failed
00:00:45.6		Subject Response: Resource Management	- Pump ONE
00:00:48.1		Recording Interval Triggered: Tracking	
00:00:48.4		Subject Response: Communications	- COM1 Response Inappropriate
00:00:49.2		Subject Response: Communications	- FREQ Integer
00:00:49.5		Subject Response: Communications	- FREQ Integer
00:00:50.8		Subject Response: Communications	- FREQ Decimal
00:00:52.7		Subject Response: Communications	- FREQ Decimal
00:00:53.0	10	Event Processed: System Monitoring	- RED Light
00:00:53.4		Subject Response: Communications	- FREQ Decimal
00:00:55.5		Subject Response: Communications	- Enter Button Selected
00:00:56.9		Subject Response: System Monitoring	- RED Light
00:01:00.0		Recording Interval Triggered: Resource Management	
00:01:03.1		Recording Interval Triggered: Tracking	
00:01:13.0	11	Event Processed: System Monitoring	- Scale TWO
00:01:15.0	12	Event Processed: Resource Management	- Pump FIVE Fixed
00:01:19.4		Subject Response: System Monitoring	- Scale TWO
00:01:19.9		Subject Response: System Monitoring	- Scale TWO Resp. Inappropriate
00:01:20.0	13	Event Processed: Communications	- COM TWO OTHER Ship
00:01:20.3		Subject Response: System Monitoring	- Scale TWO Resp. Inappropriate
00:01:24.8		Subject Response: Resource Management	- Pump FIVE
00:01:28.8		Subject Response: Resource Management	- Pump FOUR
00:01:29.7		Subject Response: Resource Management	- Pump THREE
00:01:30.0		Recording Interval Triggered: Resource Management	- Pump FOUR
00:01:31.3		Subject Response: Resource Management	- Pump ONE
00:01:39.0		Subject Response: Resource Management	- Pump EIGHT
00:01:41.5		Subject Response: Resource Management	- Pump THREE
00:01:48.5		Subject Response: Resource Management	

00:01:50.0		Event Terminated: Communications	
00:02:00.0	14	Event Processed: Scheduling	- TRACK in Auto Mode
00:02:00.0		Recording Interval Triggered: Resource Management	
00:02:05.0	15	Event Processed: Communications	- NAV TWO OTHER Ship
00:02:13.0	16	Event Processed: System Monitoring	- GREEN Light
00:02:15.8		Subject Response: System Monitoring	- GREEN Light
00:02:20.0	17	Event Processed: Resource Management	- Pump EIGHT Failed
00:02:21.7		Subject Response: Communications	- NAV2 Response Inappropriate
00:02:22.7		Subject Response: Communications	- FREQ Integer
00:02:22.9		Subject Response: Communications	- FREQ Integer
00:02:23.3		Subject Response: Communications	- FREQ Integer
00:02:24.8		Subject Response: Communications	- FREQ Decimal
00:02:25.1		Subject Response: Communications	- FREQ Decimal
00:02:25.2		Subject Response: Communications	- FREQ Decimal
00:02:25.3		Subject Response: Communications	- FREQ Decimal
00:02:25.3		Subject Response: Communications	- FREQ Decimal
00:02:25.4		Subject Response: Communications	- FREQ Decimal
00:02:25.4		Subject Response: Communications	- FREQ Decimal
00:02:25.5		Subject Response: Communications	- FREQ Decimal
00:02:25.6		Subject Response: Communications	- FREQ Decimal
00:02:25.6		Subject Response: Communications	- FREQ Decimal
00:02:26.6		Subject Response: Communications	- FREQ Decimal
00:02:28.3		Subject Response: Communications	- Enter Button Selected
00:02:30.0	19	Event Processed: Scheduling	- COMM Session Ended
00:02:30.0		Recording Interval Triggered: Resource Management	
00:02:33.0	20	Event Processed: System Monitoring	- Scale THREE
00:02:41.8		Subject Response: Resource Management	- Pump THREE
00:02:42.9		Event Terminated: System Monitoring	- Scale ONE
00:02:44.7		Subject Response: Resource Management	- Pump TWO
00:02:45.0	21	Event Processed: Scheduling	- TRACK in Manual Mode
00:02:50.0	22	Event Processed: Resource Management	- Pump EIGHT Fixed
00:02:53.0	23	Event Processed: System Monitoring	- RED Light
00:02:54.6		Subject Response: System Monitoring	- RED Light
00:03:00.0		Recording Interval Triggered: Resource Management	
00:03:00.1		Recording Interval Triggered: Tracking	
00:03:03.9		Subject Response: Resource Management	- Pump THREE
00:03:05.0	24	Event Processed: Scheduling	- COMM Session Started
00:03:05.7		Subject Response: Resource Management	- Pump ONE
00:03:06.4		Subject Response: Resource Management	- Pump TWO
00:03:08.4		Subject Response: Resource Management	- Pump EIGHT
00:03:08.9		Subject Response: Resource Management	- Pump THREE
00:03:10.0	25	Event Processed: Communications	- COM ONE OWN Ship
00:03:15.0	26	Event Processed: Resource Management	- Pump TWO Failed
00:03:15.1		Recording Interval Triggered: Tracking	
00:03:15.8		Subject Response: Communications	- COM ONE
00:03:17.0		Subject Response: Communications	- FREQ Integer
00:03:17.3		Subject Response: Communications	- FREQ Integer
00:03:18.0	27	Event Processed: Resource Management	- Pump FOUR Failed
00:03:18.6		Subject Response: Communications	- FREQ Decimal
00:03:18.9		Subject Response: Communications	- FREQ Decimal
00:03:19.1		Subject Response: Communications	- FREQ Decimal
00:03:19.4		Subject Response: Communications	- FREQ Decimal
00:03:21.1		Subject Response: Communications	- FREQ Decimal
00:03:23.7		Subject Response: Communications	- Enter Button Selected
00:03:24.6		Subject Response: Resource Management	- Pump THREE
00:03:25.0	28	Event Processed: Workload Rating Scale	

00:03:25.2		Recording Interval Triggered: Tracking	
00:03:30.0	29	Event Processed: System Monitoring	- Scale ONE
00:03:30.0		Recording Interval Triggered: Resource Management	
00:03:36.6		Subject Response: System Monitoring	- Scale ONE
00:03:45.0	30	Event Processed: Communications	- COM TWO OTHER Ship
00:03:50.0	31	Event Processed: Resource Management	- Pump TWO Fixed
00:03:55.0	32	Event Processed: Resource Management	- Pump FOUR Fixed
00:04:00.1		Recording Interval Triggered: Resource Management	
00:04:00.2		Subject Response: Resource Management	- Pump TWO
00:04:00.5	33	Event Processed: Scheduling	- TRACK in Auto Mode
00:04:02.1		Subject Response: Resource Management	- Pump FOUR
00:04:05.0	34	Event Processed: Resource Management	- Pump THREE Failed
00:04:13.0	35	Event Processed: System Monitoring	- GREEN Light
00:04:15.0		Event Terminated: Communications	
00:04:15.6		Subject Response: System Monitoring	- GREEN Light
00:04:27.3	-	Information: MATB Lost The Focus For	- 00:02.2 [min:sec.tenths]
00:04:30.0		Recording Interval Triggered: Resource Management	
00:04:31.0		Subject Response: Resource Management	- Pump ONE
00:04:31.8		Subject Response: Resource Management	- Pump TWO
00:04:32.6		Subject Response: Resource Management	- Pump EIGHT
00:04:33.0	36	Event Processed: System Monitoring	- RED Light
00:04:33.1		Subject Response: Resource Management	- Pump SEVEN
00:04:35.3		Subject Response: System Monitoring	- RED Light
00:04:39.8		Subject Response: Resource Management	- Pump ONE
00:04:40.0	37	Event Processed: Scheduling	- COMM Session Ended
00:04:44.2		Subject Response: Resource Management	- Pump TWO
00:04:45.0	38	Event Processed: Workload Rating Scale	
00:04:55.0	39	Event Processed: Resource Management	- Pump THREE Fixed
00:05:00.0	40	Event Processed: Control	

P A complete MATB_EVENTS file

```
<?xml version="1.0" encoding="UTF-8" ?>
- <!-- Multi-Attribute Task Battery Events -->
- <!-- Modified on 01-21-2011 -->
- <!-- Sample 5 minute run with all four tasks and multi WRS questionnaire
  occurences -->
- <MATB-EVENTS>
- <!-- CNTRL: Start MATB Timer -->
- <event startTime="0:00:00">
<control>START</control>
  </event>
- <!-- SCHED: Start RESMAN & SYSMON Tasks -->
- <event startTime="0:00:01">
- <sched>
<task>RESSYS</task>
<action>START</action>
<update>NULL</update>
<response>NULL</response>
  </sched>
  </event>
- <!-- SCHED: TRACK to Manual Mode -->
- <event startTime="0:00:02">
- <sched>
<task>TRACK</task>
<action>MANUAL</action>
<update>HIGH</update>
<response>MEDIUM</response>
  </sched>
  </event>
- <!-- RESMAN: Fail pump 1 -->
- <event startTime="0:00:05">
- <resman>
<fail>P1</fail>
  </resman>
  </event>
- <!-- SYSMON: Green Light OFF -->
- <event startTime="0:00:08">
- <sysmon activity="START">
<monitoringLightType>GREEN</monitoringLightType>
  </sysmon>
  </event>
- <!-- SCHED: COMM Start Session -->
- <event startTime="0:00:10">
- <sched>
<task>COMM</task>
<action>START</action>
<update>NULL</update>
<response>NULL</response>
```

```
    </sched>
    </event>
  - <!-- COMM: OTHER Ship Freq Change -->
- <event startTime="0:00:15">
- <comm>
  <ship>OTHER</ship>
  <radio>COM2</radio>
  <freq>130.725</freq>
    </comm>
    </event>
  - <!-- SYSMON: Red Light ON -->
- <event startTime="0:00:20">
- <sysmon>
  <monitoringLightType>RED</monitoringLightType>
    </sysmon>
    </event>
  - <!-- RESMAN: Fix pump 1 -->
- <event startTime="0:00:35">
- <resman>
  <fix>P1</fix>
    </resman>
    </event>
  - <!-- SYSMON: SCALE ONE UP -->
- <event startTime="0:00:38">
- <sysmon>
  <monitoringScaleNumber>ONE</monitoringScaleNumber>
  <monitoringScaleDirection>UP</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!-- COMM: OWN Ship Freq Change -->
- <event startTime="0:00:40">
- <comm>
  <ship>OWN</ship>
  <radio>COM1</radio>
  <freq>127.550</freq>
    </comm>
    </event>
  - <!-- RESMAN: Fail pump 5 -->
- <event startTime="0:00:45">
- <resman>
  <fail>P5</fail>
    </resman>
    </event>
  - <!-- SYSMON: Red Light ON -->
- <event startTime="0:00:53">
- <sysmon>
  <monitoringLightType>RED</monitoringLightType>
    </sysmon>
    </event>
```

```
  - <!-- SYSMON: SCALE TWO DOWN -->
- <event startTime="0:01:00">
- <sysmon>
  <monitoringScaleNumber>TWO</monitoringScaleNumber>
  <monitoringScaleDirection>DOWN</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!-- SYSMON: SCALE FOUR DOWN -->
- <event startTime="0:01:10">
- <sysmon>
  <monitoringScaleNumber>FOUR</monitoringScaleNumber>
  <monitoringScaleDirection>DOWN</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!-- RESMAN: Fix pump 5 -->
- <event startTime="0:01:15">
- <resman>
  <fix>P5</fix>
    </resman>
    </event>
  - <!-- COMM: OWN Ship Freq Change -->
- <event startTime="0:01:20">
- <comm>
  <ship>OWN</ship>
  <radio>COM2</radio>
  <freq>126.475</freq>
    </comm>
    </event>
  - <!-- SYSMON: SCALE TWO UP -->
- <event startTime="0:01:31">
- <sysmon>
  <monitoringScaleNumber>TWO</monitoringScaleNumber>
  <monitoringScaleDirection>UP</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!-- COMM: OWN Ship Freq Change -->
- <event startTime="0:01:45">
- <comm>
  <ship>OWN</ship>
  <radio>NAV1</radio>
  <freq>111.600</freq>
    </comm>
    </event>
  - <!-- SCHED: TRACK to Automatic Response Mode -->
- <event startTime="0:02:00">
- <sched>
  <task>TRACK</task>
  <action>AUTO</action>
  <update>NULL</update>
```

```
  <response>NULL</response>
    </sched>
    </event>
  - <!--  SYSMON: Green Light OFF   -->
- <event startTime="0:02:10">
- <sysmon activity="START">
  <monitoringLightType>GREEN</monitoringLightType>
    </sysmon>
    </event>
  - <!--  COMM: OTHER Ship Freq Change   -->
- <event startTime="0:02:20">
- <comm>
  <ship>OTHER</ship>
  <radio>NAV2</radio>
  <freq>115.050</freq>
    </comm>
    </event>
  - <!--  RESMAN: Fail pump 8    -->
- <event startTime="0:02:20">
- <resman>
  <fail>P8</fail>
    </resman>
    </event>
  - <!--  SCHED: COMM Stop Session   -->
- <event startTime="0:02:30">
- <sched>
  <task>COMM</task>
  <action>STOP</action>
  <update>NULL</update>
  <response>NULL</response>
    </sched>
    </event>
  - <!--  SYSMON: SCALE THREE UP   -->
- <event startTime="0:02:33">
- <sysmon>
  <monitoringScaleNumber>THREE</monitoringScaleNumber>
  <monitoringScaleDirection>UP</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!--  WRS questionnaire   -->
- <event startTime="0:02:40">
  <wrs>START</wrs>
    </event>
  - <!--  SCHED: TRACK to Manual Mode   -->
- <event startTime="0:02:45">
- <sched>
  <task>TRACK</task>
  <action>MANUAL</action>
  <update>MEDIUM</update>
```

```
  <response>HIGH</response>
    </sched>
    </event>
  - <!-- RESMAN: Fix pump 8    -->
- <event startTime="0:02:50">
- <resman>
  <fix>P8</fix>
    </resman>
    </event>
  - <!-- SYSMON: Red Light ON  -->
- <event startTime="0:02:53">
- <sysmon>
  <monitoringLightType>RED</monitoringLightType>
    </sysmon>
    </event>
- <event startTime="0:03:05">
- <sched>
  <task>COMM</task>
  <action>START</action>
  <update>NULL</update>
  <response>NULL</response>
    </sched>
    </event>
  - <!-- Start Communications task and make radio change   -->
- <event startTime="0:03:10">
- <comm activity="START">
  <ship>OWN</ship>
  <radio>COM1</radio>
  <freq>126.450</freq>
    </comm>
    </event>
  - <!-- RESMAN: Fail pump 2   -->
  - <event startTime="0:03:20">
- <resman>
  <fail>P2</fail>
    </resman>
    </event>
  - <!-- RESMAN: Fail pump 4    -->
- <event startTime="0:03:20">
- <resman>
  <fail>P4</fail>
    </resman>
    </event>
  - <!-- SYSMON: SCALE ONE DOWN   -->
- <event startTime="0:03:23">
- <sysmon>
  <monitoringScaleNumber>ONE</monitoringScaleNumber>
  <monitoringScaleDirection>DOWN</monitoringScaleDirection>
    </sysmon>
```

```
    </event>
  - <!-- COMM: OTHER Ship Freq Change -->
- <event startTime="0:03:45">
- <comm>
  <ship>OTHER</ship>
  <radio>COM2</radio>
  <freq>120.775</freq>
    </comm>
    </event>
  - <!-- RESMAN: Fix pump 2 -->
- <event startTime="0:03:50">
- <resman>
  <fix>P2</fix>
    </resman>
    </event>
  - <!-- RESMAN: Fix pump 4 -->
- <event startTime="0:03:55">
- <resman>
  <fix>P4</fix>
    </resman>
    </event>
  - <!-- SCHED: TRACK to Automatic Response Mode -->
- <event startTime="0:04:00">
- <sched>
  <task>TRACK</task>
  <action>AUTO</action>
  <update>NULL</update>
  <response>NULL</response>
    </sched>
    </event>
  - <!-- RESMAN: Fail pump 3 -->
- <event startTime="0:04:05">
- <resman>
  <fail>P3</fail>
    </resman>
    </event>
  - <!-- SYSMON: Green Light OFF -->
- <event startTime="0:04:13">
- <sysmon>
  <monitoringLightType>GREEN</monitoringLightType>
    </sysmon>
    </event>
  - <!-- SYSMON: SCALE TWO DOWN -->
- <event startTime="0:04:23">
- <sysmon>
  <monitoringScaleNumber>TWO</monitoringScaleNumber>
  <monitoringScaleDirection>DOWN</monitoringScaleDirection>
    </sysmon>
    </event>
```

```
  - <!--  SYSMON: Red Light ON  -->
- <event startTime="0:04:33">
- <sysmon>
  <monitoringLightType>RED</monitoringLightType>
    </sysmon>
    </event>
- <event startTime="0:04:40">
- <sched>
  <task>COMM</task>
  <action>STOP</action>
  <update>NULL</update>
  <response>NULL</response>
    </sched>
    </event>
  - <!--  SYSMON: SCALE ONE UP  -->
  - <event startTime="0:04:41">
- <sysmon>
  <monitoringScaleNumber>ONE</monitoringScaleNumber>
  <monitoringScaleDirection>UP</monitoringScaleDirection>
    </sysmon>
    </event>
  - <!--  WRS questionnaire  -->
- <event startTime="0:04:45">
  <wrs>START</wrs>
    </event>
  - <!--  RESMAN: Fix pump 3  -->
- <event startTime="0:04:55">
- <resman>
  <fix>P3</fix>
    </resman>
    </event>
  - <!--  CNTRL: Stop MATB Timer & End Run  -->
- <event startTime="0:05:00">
  <control>END</control>
    </event>
    </MATB-EVENTS>
```

P.1 MATB_EVENTS-sample-5min.xml

Events for the first 53 seconds of the sample file.

MATB_EVENTS_sample-5min.xml | MATB_EVENTS_sample-20min.xml

```
<!-- SCHED: TRACK Manual Mode -->
<event startTime="0:00:02">
  <sched>
    <task>TRACK</task>
    <action>MANUAL</action>
    <update>HIGH</update>
    <response>MEDIUM</response>
  </sched>
</event>
<!-- RESMAN: Fail pump 1  -->
<event startTime="0:00:05">
  <resman>
    <fail>P1</fail>
  </resman>
</event>
<!-- SYSMON: Turn Normally ON to OFF -->
<event startTime="0:00:13">
  <sysmon>
    <monitoringLightType>GREEN</monitoringLightType>
  </sysmon>
</event>
<!-- SCHED: Start COMM Session -->
<event startTime="0:00:34">
  <sched>
    <task>COMM</task>
    <action>START</action>
    <update>NULL</update>
    <response>NULL</response>
  </sched>
</event>
<!-- RESMAN: Fix pump 1  -->
<event startTime="0:00:35">
  <resman>
    <fix>P1</fix>
  </resman>
</event>
<!-- COMM: Own ship radio freq change -->
<event startTime="0:00:40">
  <comm>
    <ship>OWN</ship>
    <radio>COM1</radio>
    <freq>124.575</freq>
  </comm>
</event>
<!-- RESMAN: Fail pump 5  -->
<event startTime="0:00:45">
  <resman>
    <fail>P5</fail>
  </resman>
</event>
<!-- SYSMON: Turn Normally OFF to ON -->
<event startTime="0:00:53">
  <sysmon>
    <monitoringLightType>RED</monitoringLightType>
  </sysmon>
```

```
-- Task event information -->
  <task_list>
      <task>
          <filename> SCHED.xml </filename>
          <name> SCHED </name>
          <color>
              <red>173</red>
              <green>216</green>
              <blue>230</blue>
          </color>
          <priority> 0 </priority>
      </task>
      <task>
          <filename> SYSMON.xml </filename>
          <name> SYSMON </name>
          <color>
              <red>70</red>
              <green>130</green>
              <blue>180</blue>
          </color>
          <priority> 1 </priority>
      </task>
      <task>
          <filename> COMM.xml </filename>
          <name> COMM </name>
          <color>
              <red>144</red>
              <green>238</green>
              <blue>144</blue>
          </color>
          <priority> 2 </priority>
      </task>
      <task>
          <filename> RESMAN.xml </filename>
          <name> RESMAN </name>
          <color>
              <red>210</red>
              <green>210</green>
              <blue>210</blue>
          </color>
          <priority> 3 </priority>
      </task>
      <task>
          <filename> WRS.xml </filename>
          <name> WRS </name>
          <color>
              <red>255</red>
              <green>180</green>
              <blue>160</blue>
          </color>
          <priority> 1 </priority>
      </task>
  </task list>
```

```
<!-- Configuration information -->
    <config type="RUN_INITIAL">
        <run_length>
            <min>
                <hours> 0 </hours>
                <minutes> 0 </minutes>
                <seconds> 1 </seconds>
            </min>
            <target>
                <hours> 0 </hours>
                <minutes> 20 </minutes>
                <seconds> 0 </seconds>
            </target>
            <max>
                <hours> 2 </hours>
                <minutes> 0 </minutes>
                <seconds> 0 </seconds>
            </max>
        </run_length>
        <num_events>
            <min> 5 </min>
            <max> 50 </max>
        </num_events>
    </config>
</EFB-CONFIG>
```

P.2 Appendix CONTROL.xml

CONTROL.xml

```
<?xml version="1.0" encoding="utf-8"?>
<!--    CONTROL.xml                    -->
<!--    Modified on 08-20-2010                -->
<!--    Required for MATB, and not selectable by user   -->
<CONTROL>
    <control_item>
        <key>control</key>
        <type>header</type>
        <value>START</value>
    </control_item>

    <control_item>
        <key>control</key>
        <type>footer</type>
        <value>END</value>
    </control_item>
</CONTROL>
```

P.3 Appendix RESMAN.xml

```
<?xml version="1.0" encoding="utf-8"?>
<!--    RESMAN.xml                -->
<!--    Modified on 08-13-2010           -->
<!--                          -->
<!--    Output Example:               -->
<!--    <event startTime="0:03:20">      -->
<!--       <resman>               -->
<!--          <fix>P1</fix>           -->
<!--       </resman>                  -->
<!--    </event>                              -->
<!--                          -->
<TASK-PROPERTIES>
    <name>Resource Management</name>
    <key>resman</key>
    <property>
        <name>Action</name>
        <values type="list" num_values="2">
            <value link="fix">fix</value>
            <value link="fail">fail</value>
        </values>
    </property>
    <property link="fix">
        <name>Pump</name>
        <key>fix</key>
        <values type="list" num_values="8">
            <value>P1</value>
            <value>P2</value>
            <value>P3</value>
            <value>P4</value>
            <value>P5</value>
            <value>P6</value>
            <value>P7</value>
            <value>P8</value>
        </values>
    </property>
    <property link="fail">
        <name>Pump</name>
        <key>fail</key>
        <values type="list" num_values="8">
            <value>P1</value>
            <value>P2</value>
            <value>P3</value>
            <value>P4</value>
            <value>P5</value>
            <value>P6</value>
            <value>P7</value>
            <value>P8</value>
        </values>
    </property>
</TASK-PROPERTIES>
```

Q Multi-Attribute Task Battery (MATB) Communications Task Audio Scripts and Filenames

Radio communications are a critical component of the air traffic control (ATC) system. Flight crews must monitor ATC radio communications to avoid potential traffic conflicts and be precisely where the air traffic controller wants them to be (taxiway, runway, arrival / departure route, etc). The flight crew will normally communicate with multiple controllers and on multiple radio frequencies during a single flight.

One of the tasks in MATB is the radio communications task, where short audio utterances are played and the subject responds to the instructions. The audio utterances simulate an air traffic controller directing the flight deck crew to tune either one of two voice communication radios or one of two navigation radio aids (e.g. VHF Omnidirectional Radio Range or VOR) to a new frequency. The subject tunes the radio if the message is for them and ignores it when it is intended for another aircraft.

The time sequence of an experimental run is managed by the contents of an XML file called the MATB_EVENTS file. The correct audio file to play is selected by file name which is composed by concatenating three elements from the events file. These are type of aircraft (known as "ship"), the "radio" name and the "freq" (frequency). A couple of examples from MATB_EVENTS file are:

```
<comm>
      <ship>OWN</ship>
      <radio>COM1</radio>
      <freq>118.025</freq>
</comm>
```

And

```
<comm>
      <ship>OTHER</ship>
      <radio>NAV2</radio>
      <freq>112.550</freq>
</comm>
```

The audio filename for the first would be OWN_COM1_118-025.wav and for the second, OTHER_NAV2_112-550.wav.

The OWN SHIP utterance for the first named file would be:
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE ONE EIGHT POINT ZERO TWO FIVE"

And for the OTHER SHIP file, the utterance would be:
"FEDEX THREE ZERO THREE, FEDEX THREE ZERO THREE, tune your NAV TWO radio to frequency ONE ONE TWO POINT FIVE FIVE ZERO"

Each digit of the frequency is pronounced phonetically rather than spoken as a number, for example "ONE ONE EIGHT POINT ZERO TWO FIVE" rather than "One Eighteen and twenty five thousandths".

An aeronautical radio call sign consists of two parts, the first part is a nickname to differentiate similar named airlines or organizations. They are not the same as an airline's International Civil Aviation Organization (ICAO) or International Air Transport Association (IATA) designations. The second part is a numeric designation, usually the flight identification number for an airline or the last four characters of the registration marking for military or business aircraft. However, there are many exceptions, to either avoid confusion caused by similar flight identification numbers in proximity or some other reason. Military aircraft flying tactical missions do not normally follow this convention. Langley Research Center (LaRC) uses NASA 5xx for its aircraft.

The nickname part of the call sign is not spoken phonetically, but the numeric part normally is. The call sign used in MATB for OWN is always "NASA 504", which is LaRC's Cessna 206. This call sign would normally be spoken as "NASA FIVE ZERO FOUR", rather than "NOVEMBER ALPHA SIERRA ALPHA FIVE ZERO FOUR".

There are no NASA call signs in the list of OTHER aircraft. A list of real world OTHER calls signs used for the radio communications is listed in Appendix Q.1.9.

MATB expects the files to be recorded in the Wave Form format (".wav" file extension). Once recorded the files are placed in the "\MATB\audio" sub-folder. The filenames with the corresponding event XML file entry to play it are listed in Appendix Q.1.11.

Appendix Q.1 contains a list of 80 filenames along with the audio script for each. There are 40 each for OWN ship and OTHER ship, with 10 for each of the four radios in each ship category. The number of available files allows almost two communications events per minute without duplicates. As it is typical for flight deck crews to communicate with a number of air traffic controllers during the course of a flight, it would be appropriate for these recordings to be made by more than one individual's voice.

ATC radio communications protocol follows this format:

Full call sign of the called aircraft
Name of the ATC calling facility / function
Request

Two prime reasons for this are the number of aircraft on frequency and that flight deck crews may be monitoring more than one radio simultaneously. As this is not the situation during a MATB run, the call sign will be repeated in place of the ATC calling facility / function. While ICAO standards required that radio frequencies be communicated by speaking each number in a single format with "POINT" annunciated for the decimal point, it has become common practice in some regions to ignore this to save time. For instance, a COM radio frequency of "132.650" may be read back as "One thirty two sixty five". While this may save time, there is less chance of misunderstanding adhering to the ICAO standard. The MATB scripts follow the ICAO standard.

Q.1 Scripts / Audio Filename Pairs

Q.1.1 NASA 504 Communications radio number ONE

1. OWN_COM1_124-575.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO FOUR POINT FIVE SEVEN FIVE”

2. OWN_COM1_125-550.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO FIVE POINT FIVE FIVE ZERO”

3. OWN_COM1_126-525.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO SIX POINT FIVE TWO FIVE”

4. OWN_COM1_127-500.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO SEVEN POINT FIVE ZERO ZERO”

5. OWN_COM1_128-475.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO EIGHT POINT FOUR SEVEN FIVE”

6. OWN_COM1_129-450.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO NINER POINT FOUR FIVE ZERO”

7. OWN_COM1_128-575.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO EIGHT POINT FIVE SEVEN FIVE”

8. OWN_COM1_127-550.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO SEVEN POINT FIVE FIVE ZERO”

9. OWN_COM1_126-450.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO SIX POINT FOUR FIVE ZERO”

10. OWN_COM1_125-500.wav
“NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM ONE radio to frequency ONE TWO FIVE POINT FIVE ZERO ZERO”

Q.1.2 NASA 504 Communications radio number TWO

11. OWN_COM2_129-575.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO NINER POINT FIVE SEVEN FIVE"

12. OWN_COM2_128-550.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO EIGHT POINT FIVE FIVE ZERO"

13. OWN_COM2_127-525.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO SEVEN POINT FIVE TWO FIVE"

14. OWN_COM2_126-475.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO SIX POINT FOUR SEVEN FIVE"

15. OWN_COM2_125-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO FIVE POINT FIVE ZERO ZERO"

16. OWN_COM2_124-450.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO FOUR POINT FOUR FIVE ZERO"

17. OWN_COM2_125-575.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO FIVE POINT FIVE SEVEN FIVE"

18. OWN_COM2_126-550.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO SIX POINT FIVE FIVE ZERO"

19. OWN_COM2_127-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO SEVEN POINT FIVE ZERO ZERO"

20. OWN_COM2_128-525.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your COM TWO radio to frequency ONE TWO EIGHT POINT FIVE TWO FIVE"

Q.1.3 NASA 504 Navigation radio number ONE

21. OWN_NAV1_110-650.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE ZERO POINT SIX FIVE ZERO "

22. OWN_ NAV1_111-600.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE ONE POINT SIX ZERO ZERO"

23. OWN_ NAV1_112-550.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE TWO POINT FIVE FIVE ZERO"

24. OWN_ NAV1_113-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE THREE POINT FIVE ZERO ZERO"

25. OWN_ NAV1_114-450.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE FOUR POINT FOUR FIVE ZERO"

26. OWN_ NAV1_115-400.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE FIVE POINT FOUR ZERO ZERO"

27. OWN_ NAV1_114-650.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE FOUR POINT SIX FIVE ZERO"

28. OWN_ NAV1_113-600.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE THREE POINT SIX ZERO ZERO"

29. OWN_ NAV1_112-450.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE TWO POINT FOUR FIVE ZERO"

30. OWN_ NAV1_111-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV ONE radio to frequency ONE ONE ONE POINT FIVE ZERO ZERO"

Q.1.4 NASA 504 Navigation radio number TWO

31. OWN_NAV2_115-650.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE FIVE POINT SIX FIVE ZERO "

32. OWN_ NAV2_114-600.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE FOUR POINT SIX ZERO ZERO"

33. OWN_ NAV2_113-550.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE THREE POINT FIVE FIVE ZERO"

34. OWN_ NAV2_112-450.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE TWO POINT FOUR FIVE ZERO"

35. OWN_ NAV2_111-400.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE ONE POINT FOUR ZERO ZERO"

36. OWN_ NAV2_110-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE ZERO POINT FIVE ZERO ZERO"

37. OWN_ NAV2_111-650.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE ONE POINT SIX FIVE ZERO"

38. OWN_ NAV2_112-600.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE TWO POINT SIX ZERO ZERO"

39. OWN_ NAV2_113-500.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE THREE POINT FIVE ZERO ZERO"

40. OWN_ NAV2_114-450.wav
"NASA FIVE ZERO FOUR, NASA FIVE ZERO FOUR, tune your NAV TWO radio to frequency ONE ONE FOUR POINT FOUR FIVE ZERO"

Q.1.5 Other Ship Communications radio number ONE

41. OTHER_COM1_118-325.wav
"CITRIS TWO ONE ONE, CITRIS TWO ONE ONE, tune your COM ONE radio to frequency ONE ONE EIGHT POINT THREE TWO FIVE"

42. OTHER_COM1_120-825.wav
"ACEY FIVE ONE SEVEN ONE, ACEY FIVE ONE SEVEN ONE, tune your COM ONE radio to frequency ONE TWO ZERO POINT EIGHT TWO FIVE"

43. OTHER_COM1_124-350.wav
"DELTA ONE FIVE ONE NINER, DELTA ONE FIVE ONE NINER, tune your COM ONE radio to frequency ONE TWO FOUR POINT THREE FIVE ZERO"

44. OTHER_COM1_126-175.wav
"FEDEX THREE ZERO THREE, FEDEX THREE ZERO THREE, tune your COM ONE radio to frequency ONE TWO SIX POINT ONE SEVEN FIVE"

45. OTHER_COM1_127-725.wav
"CITRIS NINER ZERO TWO, CITRIS NINER ZERO TWO, tune your COM ONE radio to frequency ONE TWO SEVEN POINT SEVEN TWO FIVE"

46. OTHER_COM1_128-525.wav
"ACEY FIVE TWO EIGHT EIGHT, ACEY FIVE TWO EIGHT EIGHT, tune your COM ONE radio to frequency ONE TWO EIGHT POINT FIVE TWO FIVE"

47. OTHER_COM1_130-875.wav
"UPS TWO ZERO SEVEN, UPS TWO ZERO SEVEN, tune your COM ONE radio to frequency ONE THREE ZERO POINT EIGHT SEVEN FIVE"

48. OTHER_COM1_132-950.wav
"DELTA ONE SEVEN ZERO ONE, DELTA ONE SEVEN ZERO ONE, tune your COM ONE radio to frequency ONE THREE TWO POINT NINER FIVE ZERO"

49. OTHER_COM1_134-175.wav
"ACEY FIVE SIX TWO ZERO, ACEY FIVE SIX TWO ZERO, tune your COM ONE radio to frequency ONE THREE FOUR POINT ONE SEVEN FIVE"

50. OTHER_COM1_135-225.wav
"CITRIS SIX FOUR TWO, CITRIS SIX FOUR TWO, tune your COM ONE radio to frequency ONE THREE FIVE POINT TWO TWO FIVE"

Q.1.6 Other Ship Communications radio number TWO

51. OTHER_COM2_118-275.wav
"CITRIS TWO ONE ONE , CITRIS TWO ONE ONE, tune your COM TWO radio to frequency ONE ONE EIGHT POINT TWO SEVEN FIVE"

52. OTHER_COM2_120-775.wav
"ACEY FIVE ONE SEVEN ONE, ACEY FIVE ONE SEVEN ONE, tune your COM TWO radio to frequency ONE TWO ZERO POINT SEVEN SEVEN FIVE"

53. OTHER_COM2_124-500.wav
"DELTA ONE FIVE ONE NINER, DELTA ONE FIVE ONE NINER, tune your COM TWO radio to frequency ONE TWO FOUR POINT FIVE ZERO ZERO"

54. OTHER_COM2_126-025.wav
"FEDEX THREE ZERO THREE, FEDEX THREE ZERO THREE, tune your COM TWO radio to frequency ONE TWO SIX POINT ZERO TWO FIVE"

55. OTHER_COM2_127-675.wav
"CITRIS NINER ZERO TWO, CITRIS NINER ZERO TWO, tune your COM TWO radio to frequency ONE TWO SEVEN POINT SIX SEVEN FIVE"

56. OTHER_COM2_128-475.wav
"ACEY FIVE TWO EIGHT EIGHT, ACEY FIVE TWO EIGHT EIGHT, tune your COM TWO radio to frequency ONE TWO EIGHT POINT FOUR SEVEN FIVE"

57. OTHER_COM2_130-725.wav
"UPS TWO ZERO SEVEN, UPS TWO ZERO SEVEN, tune your COM TWO radio to frequency ONE THREE ZERO POINT SEVEN TWO FIVE"

58. OTHER_COM2_132-800.wav
"DELTA ONE SEVEN ZERO ONE, DELTA ONE SEVEN ZERO ONE, tune your COM TWO radio to frequency ONE THREE TWO POINT EIGHT ZERO ZERO"

59. OTHER_COM2_134-025.wav
"ACEY FIVE SIX TWO ZERO, ACEY FIVE SIX TWO ZERO, tune your COM TWO radio to frequency ONE THREE FOUR POINT ZERO TWO FIVE"

60. OTHER_COM2_135-175.wav
"CITRIS SIX FOUR TWO, CITRIS SIX FOUR TWO, tune your COM TWO radio to frequency ONE THREE FIVE POINT ONE SEVEN FIVE"

Q.1.7 Other Ship Navigation radio number ONE

61. OTHER_NAV1_108-350.wav
"CITRIS TWO ONE ONE , CITRIS TWO ONE ONE, tune your NAV ONE radio to frequency ONE ZERO EIGHT POINT THREE FIVE ZERO "

62. OTHER_ NAV1_109-250.wav
"ACEY FIVE ONE SEVEN ONE, ACEY FIVE ONE SEVEN ONE, tune your NAV ONE radio to frequency ONE ZERO NINER POINT TWO FIVE ZERO"

63. OTHER_ NAV1_110-400.wav
"DELTA ONE FIVE ONE NINER, DELTA ONE FIVE ONE NINER, tune your NAV ONE radio to frequency ONE ONE ZERO POINT FOUR ZERO ZERO"

64. OTHER_ NAV1_111-950.wav
"FEDEX THREE ZERO THREE, FEDEX THREE ZERO THREE, tune your NAV ONE radio to frequency ONE ONE ONE POINT NINER FIVE ZERO"

65. OTHER_ NAV1_112-150.wav
"CITRIS NINER ZERO TWO, CITRIS NINER ZERO TWO, tune your NAV ONE radio to frequency ONE ONE TWO POINT ONE FIVE ZERO"

66. OTHER_ NAV1_113-000.wav
"ACEY FIVE TWO EIGHT EIGHT, ACEY FIVE TWO EIGHT EIGHT, tune your NAV ONE radio to frequency ONE ONE THREE POINT ZERO ZERO ZERO"

67. OTHER_ NAV1_114-500.wav
"UPS TWO ZERO SEVEN, UPS TWO ZERO SEVEN, tune your NAV ONE radio to frequency ONE ONE FOUR POINT FIVE ZERO ZERO"

68. OTHER_ NAV1_115-750.wav
"DELTA ONE SEVEN ZERO ONE, DELTA ONE SEVEN ZERO ONE, tune your NAV ONE radio to frequency ONE ONE FIVE POINT SEVEN FIVE ZERO"

69. OTHER_ NAV1_116-450.wav
"ACEY FIVE SIX TWO ZERO, ACEY FIVE SIX TWO ZERO, tune your NAV ONE radio to frequency ONE ONE SIX POINT FOUR FIVE ZERO"

70. OTHER_ NAV1_117-650.wav
"CITRIS SIX FOUR TWO, CITRIS SIX FOUR TWO, tune your NAV ONE radio to frequency ONE ONE SEVEN POINT SIX FIVE ZERO"

Q.1.8 Other Ship Navigation radio number TWO

71. OTHER_NAV2_108-750.wav
"CITRIS TWO ONE ONE , CITRIS TWO ONE ONE, tune your NAV TWO radio to frequency ONE ZERO EIGHT POINT SEVEN FIVE ZERO "

72. OTHER_ NAV2_109-650.wav
"ACEY FIVE ONE SEVEN ONE, ACEY FIVE ONE SEVEN ONE, tune your NAV TWO radio to frequency ONE ZERO NINER POINT SIX FIVE ZERO"

73. OTHER_ NAV2_110-800.wav
"DELTA ONE FIVE ONE NINER, DELTA ONE FIVE ONE NINER, tune your NAV TWO radio to frequency ONE ONE ZERO POINT EIGHT ZERO ZERO"

74. OTHER_ NAV2_111-350.wav
"FEDEX THREE ZERO THREE, FEDEX THREE ZERO THREE, tune your NAV TWO radio to frequency ONE ONE ONE POINT THREE FIVE ZERO"

75. OTHER_ NAV2_112-550.wav
"CITRIS NINER ZERO TWO, CITRIS NINER ZERO TWO, tune your NAV TWO radio to frequency ONE ONE TWO POINT FIVE FIVE ZERO"

76. OTHER_ NAV2_113-400.wav
"ACEY FIVE TWO EIGHT EIGHT, ACEY FIVE TWO EIGHT EIGHT, tune your NAV TWO radio to frequency ONE ONE THREE POINT FOUR ZERO ZERO"

77. OTHER_ NAV2_114-900.wav
"UPS TWO ZERO SEVEN, UPS TWO ZERO SEVEN, tune your NAV TWO radio to frequency ONE ONE FOUR POINT NINER ZERO ZERO"

78. OTHER_ NAV2_115-050.wav
"DELTA ONE SEVEN ZERO ONE, DELTA ONE SEVEN ZERO ONE, tune your NAV TWO radio to frequency ONE ONE FIVE POINT ZERO FIVE ZERO"

79. OTHER_ NAV2_116-850.wav
"ACEY FIVE SIX TWO ZERO, ACEY FIVE SIX TWO ZERO, tune your NAV TWO radio to frequency ONE ONE SIX POINT EIGHT FIVE ZERO"

80. OTHER_ NAV2_117-950.wav
"CITRIS SIX FOUR TWO, CITRIS SIX FOUR TWO, tune your NAV TWO radio to frequency ONE ONE SEVEN POINT NINER FIVE ZERO"

Q.1.9 Airline Call Signs

CALL SIGN	AIRLINE
American	American Airlines
Acey	Atlantic Southeast Airlines, Inc. (ASA)
Amtran	ATA Airlines
Cactus	American West Airlines
Citris	Air Tran Airlines
Continental	Continental Airlines
Delta	Delta Airlines
Dynasty	China Airlines
FedEx	Federal Express
Shamrock	Aer Lingus
Southwest	Southwest Airlines
Speedbird	British Airways
United	United Airlines
UPS	United Parcel Service
US Air	US Airways
Virair	Virgin Atlantic Airways

Q.1.10 FAA Radiotelephony Phonetic Alphabet with Pronunciation

CHARACTER	*MORSE CODE*	*TELEPHONY*	*PHONIC (PRONUNCIATION)*
A	• —	Alfa	(AL-FAH)
B	— • • •	Bravo	(BRAH-VOH)
C	— • — •	Charlie	(CHAR-LEE) or (SHAR-LEE)
D	— • •	Delta	(DELL-TAH)
E	•	Echo	(ECK-OH)
F	• • — •	Foxtrot	(FOKS-TROT)
G	— — •	Golf	(GOLF)
H	• • • •	Hotel	(HOH-TEL)
I	• •	India	(IN-DEE-AH)
J	• — — —	Juliet	(JEW-LEE-ETT
K	— • —	Kilo	(KEY-LOH)
L	• — • •	Lima	(LEE-MAH)
M	— —	Mike	(MIKE)
N	— •	November	(NO-VEM-BER)
O	— — —	Oscar	(OSS-CAH)
P	• — — •	Papa	(PAH-PAH)
Q	— — • —	Quebec	(KEH-BECK)
R	• — •	Romeo	(ROW-ME-OH)
S	• • •	Sierra	(SEE-AIR-RAH)
T	—	Tango	(TANG-GO)
U	• • —	Uniform	(YOU-NEE-FORM) or (OO-NEE-FORM)
V	• • • —	Victor	(VIK-TAH)
W	• — —	Whiskey	(WISS-KEY)
X	— • • —	Xray	(ECKS-RAY)
Y	— • — —	Yankee	(YANG-KEY)
Z	— — • •	Zulu	(ZOO-LOO)
1	• — — — —	One	(WUN)
2	• • — — —	Two	(TOO)
3	• • • — —	Three	(TREE)
4	• • • • —	Four	(FOW-ER)
5	• • • • •	Five	(FIFE)
6	— • • • •	Six	(SIX)
7	— — • • •	Seven	(SEV-EN)
8	— — — • •	Eight	(AIT)
9	— — — — •	Nine	(NIN-ER)
0	— — — — —	Zero	(ZEE-RO)

Q.1.11 Audio Filename with Corresponding Events File Entry

#	Audio Filename	MATB_EVENT XML File Entry
1	OWN_COM1_124-575.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>124.575</freq> </comm>
2	OWN_COM1_125-550.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>125.550</freq> </comm>
3	OWN_COM1_126-525.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>126.525</freq> </comm>
4	OWN_COM1_127-500.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>127.500</freq> </comm>
5	OWN_COM1_128-475.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>128.475</freq> </comm>
6	OWN_COM1_129-450.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>129.450</freq> </comm>
7	OWN_COM1_128-575.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>128.575</freq> </comm>
8	OWN_COM1_127-550.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>127.550</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
9	OWN_COM1_126-450.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>126.450</freq> </comm>
10	OWN_COM1_125-500.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>125.500</freq> </comm>
11	OWN_COM2_129-575.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>129.575</freq> </comm>
12	OWN_COM2_128-550.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>128.550</freq> </comm>
13	OWN_COM2_127-525.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>127.525</freq> </comm>
14	OWN_COM2_126-475.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>126.475</freq> </comm>
15	OWN_COM2_125-500.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>125.500</freq> </comm>
16	OWN_COM2_124-450.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>124.450</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
17	OWN_COM2_125-575.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>125.575</freq> </comm>
18	OWN_COM2_126-550.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>126.550</freq> </comm>
19	OWN_COM2_127-500.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>127.500</freq> </comm>
20	OWN_COM2_128-525.wav	<comm> <ship>OWN</ship> <radio>COM2</radio> <freq>128.525</freq> </comm>
21	OWN_NAV1_110-650.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>110.650</freq> </comm>
22	OWN_ NAV1_111-600.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>111.600</freq> </comm>
23	OWN_ NAV1_112-550.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>112.550</freq> </comm>
24	OWN_ NAV1_113-500.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>113.500</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
25	OWN_ NAV1_114-450.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>114.450</freq> </comm>
26	OWN_ NAV1_115-400.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>115.400</freq> </comm>
27	OWN_ NAV1_114-650.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>114.650</freq> </comm>
28	OWN_ NAV1_113-600.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>113.600</freq> </comm>
29	OWN_ NAV1_112-450.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>112.450</freq> </comm>
30	OWN_ NAV1_111-500.wav	<comm> <ship>OWN</ship> <radio>NAV1</radio> <freq>111.500</freq> </comm>
31	OWN_NAV2_115-650.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>115.650</freq> </comm>
32	OWN_ NAV2_114-600.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>114.600</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
33	OWN_ NAV2_113-550.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>113.550</freq> </comm>
34	OWN_ NAV2_112-450.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>112.450</freq> </comm>
35	OWN_ NAV2_111-400.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>111.400</freq> </comm>
36	OWN_ NAV2_110-500.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>110.500</freq> </comm>
37	OWN_ NAV2_111-650.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>111.650</freq> </comm>
38	OWN_ NAV2_112-600.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>112.600</freq> </comm>
39	OWN_ NAV2_113-500.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>113.500</freq> </comm>
40	OWN_ NAV2_114-450.wav	<comm> <ship>OWN</ship> <radio>NAV2</radio> <freq>114.450</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
41	OTHER_COM1_118-325.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>118.325</freq> </comm>
42	OTHER_COM1_120-825.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>120.825</freq> </comm>
43	OTHER_COM1_124-350.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>124.350</freq> </comm>
44	OTHER_COM1_126-175.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>126.175</freq> </comm>
45	OTHER_COM1_127-725.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>127.725</freq> </comm>
46	OTHER_COM1_128-525.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>128.525</freq> </comm>
47	OTHER_COM1_130-875.wav	<comm> <ship>OWN</ship> <radio>COM1</radio> <freq>130.875</freq> </comm>
48	OTHER_COM1_132-950.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>132.950</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
49	OTHER_COM1_134-175.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>134.175</freq> </comm>
50	OTHER_COM1_135-225.wav	<comm> <ship>OTHER</ship> <radio>COM1</radio> <freq>135.225</freq> </comm>
51	OTHER_COM2_118-275.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>118.275</freq> </comm>
52	OTHER_COM2_120-775.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>120.775</freq> </comm>
53	OTHER_COM2_124-500.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>124.500</freq> </comm>
54	OTHER_COM2_126-025.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>126.025</freq> </comm>
55	OTHER_COM2_127-675.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>127.675</freq> </comm>
56	OTHER_COM2_128-475.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>128.475</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
57	OTHER_COM2_130-725.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>130.725</freq> </comm>
58	OTHER_COM2_132-800.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>132.800</freq> </comm>
59	OTHER_COM2_134-025.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>134.025</freq> </comm>
60	OTHER_COM2_135-175.wav	<comm> <ship>OTHER</ship> <radio>COM2</radio> <freq>135.175</freq> </comm>
61	OTHER_NAV1_108-350.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>108.350</freq> </comm>
62	OTHER_ NAV1_109-250.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>109.250</freq> </comm>
63	OTHER_ NAV1_110-400.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>110.400</freq> </comm>
64	OTHER_ NAV1_111-950.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>111.950</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
65	OTHER_ NAV1_112-150.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>112.150</freq> </comm>
66	OTHER_ NAV1_113-000.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>113.000</freq> </comm>
67	OTHER_ NAV1_114-500.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>114.500</freq> </comm>
68	OTHER_ NAV1_115-750.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>115.750</freq> </comm>
69	OTHER_ NAV1_116-450.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>116.450</freq> </comm>
70	OTHER_ NAV1_117-650.wav	<comm> <ship>OTHER</ship> <radio>NAV1</radio> <freq>117.650</freq> </comm>
71	OTHER_NAV2_108-750.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>108.750</freq> </comm>
72	OTHER_ NAV2_109-650.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>109.650</freq> </comm>

#	Audio Filename	MATB_EVENT XML File Entry
73	OTHER_ NAV2_110-800.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>110.800</freq> </comm>
74	OTHER_ NAV2_111-350.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>111.350</freq> </comm>
75	OTHER_ NAV2_112-550.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>112.550</freq> </comm>
76	OTHER_ NAV2_113-400.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>113.400</freq> </comm>
77	OTHER_ NAV2_114-900.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>114.900</freq> </comm>
78	OTHER_ NAV2_115-050.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>115.050</freq> </comm>
79	OTHER_ NAV2_116-850.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>116.850</freq> </comm>
80	OTHER_ NAV2_117-950.wav	<comm> <ship>OTHER</ship> <radio>NAV2</radio> <freq>117.950</freq> </comm>

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
01- 07 - 2011	Technical Memorandum	

4. TITLE AND SUBTITLE

The Multi-Attribute Task Battery II (MATB-II) Software for Human Performance and Workload Research: A User's Guide

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Santiago-Espada, Yamira; Myer, Robert R.; Latorella, Kara A.; Comstock, James R., Jr.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

534723.02.04.07

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

NASA Langley Research Center
Hampton, VA 23681-2199

8. PERFORMING ORGANIZATION REPORT NUMBER

L-20031

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSOR/MONITOR'S ACRONYM(S)

NASA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

NASA/TM-2011-217164

12. DISTRIBUTION/AVAILABILITY STATEMENT

Unclassified Unlimited
Subject Category 53
Availability: NASA CASI (443) 757-5802

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Multi-Attribute Task Battery (MAT Battery), a computer-based task designed to evaluate operator performance and workload, has been redeveloped to operate in Windows XP Service Pack 3, Windows Vista and Windows 7 operating systems. MATB-II includes essentially the same tasks as the original MAT Battery, plus new configuration options including a graphical user interface for controlling modes of operation. MATB-II can be executed either in training or testing mode, as defined by the MATB-II configuration file. The configuration file also allows set up of the default timeouts for the tasks, the flow rates of the pumps and tank levels of the Resource Management (RESMAN) task. MATB-II comes with a default event file that an experimenter can modify and adapt to his/her needs.

15. SUBJECT TERMS

human performance evaluation, multi-task performance workload, multiple task environments, synthetic work battery, workload evaluation

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			STI Help Desk (email: help@sti.nasa.gov)
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	269	(443) 757-5802