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(2 of 4: User Manual)

SCHEDULING MANAGEMENT AID FOR RISK TRACKING PROTOTYPE FOR THE USN SURFACE FLEET

by

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Scheduling Management Aid for Risk Tracking

Risk Assessment Tool User Manual

Version 1.0

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REVISION CHANGE RECORD

Revision	Date	Change Description	Software Version
1.0	December 1, 2020	Initial release	1.0

PREFACE

The Scheduling Management Aid for Risk Tracking (SMART) risk assessment tool was designed to systematically collect user activity data and provide users with trend analysis and human performance risk assessment data. The decision aid's heuristics and outputs were created to enable users to make data-driven crew resource management decisions and implement targeted human performance risk mitigations. The current version is configured for use onboard ships but may be adapted for use by other entities with a similar organizational structure. This manual provides users with information regarding the technical aspects of the tool (e.g., formatting structure, formulas, etc.), operator instructions, and troubleshooting steps.

Additional supplementary materials are available for reference. Parties interested in obtaining a copy of any or all the supplementals listed are directed to contact the Naval Postgraduate School Dudley Knox Library:

1. SMART Template: This macro-enabled workbook contains the SMART prototype. The file contains some pre-filled data fields to provide users with illustrative examples.
2. SMART User Manual: This file contains detailed information regarding the technical aspects of the prototype (e.g., formatting structure, formulas, etc.), operator instructions, and troubleshooting steps.
3. SMART Data File: This macro-enabled spreadsheet contains the notional data created for the thesis along with the results utilized during data analysis.
4. SMART Tutorial Demonstration: This presentation contains visual and audio narrations to assist users with employing the SMART prototype. The presentation also contains troubleshooting recommendations, functionality demonstrations, and user tips for the prototype.

I. BACKGROUND

The motivation behind the creation of the Scheduling Management Aid for Risk Tracking (SMART) risk assessment tool was to reduce the likelihood of surface fleet mishaps like the four that occurred in 2017. Two separate collisions involving the *USS Fitzgerald* (DDG 62) and the *USS John S. McCain* (DDG 56) were fatal and resulted in the deaths of 17 Sailors and injury to many more. These mishaps resulted in degraded operational readiness, reduced mission availability, and increased operational tempos for the already limited available ships. Moreover, the unplanned repair costs for the *USS Fitzgerald* and the *USS John S. McCain* were estimated upwards of $700 million taxpayer dollars (LaGrone, 2020; Ziezulewicz, 2018; Werner, 2017). One of the findings from the *Comprehensive Review of Recent Surface Force Incidents* was that "Fatigue or ineffective fatigue/rest management was embedded in the four key mishaps that occurred in the Western Pacific" (U.S. Fleet Forces Command, 2017, p. 97).

During the same year, the Department of the Navy published the *Comprehensive Fatigue and Endurance Management Policy*. This policy established crew rest requirements and workday limits, mandated crew endurance training, and codified the use of circadian-based watchbills and shipboard routines designed to optimize watchstander alertness and sleep recuperation (DON, 2017). The policy's intent was to ensure that "Sailors are adequately rested for safe, professional shipboard operations to deliver enhanced warfighting effectiveness" (DON, 2017, p. 1). Commanding Officers are expected to assess and mitigate for risk during naval operations by using tools such as the Individual Risk Management Tool and weighing planning considerations like activity time guidelines (DON, 2017). Fatigue risk indicators such as prolonged wakefulness and insufficient sleep are associated with increased human performance risk (Shattuck et al., 2018; Shattuck & Matsangas, 2014).

While the 2017 *CFEMP* established work and rest hour guidelines and mandated circadian-based watchbills (DON, 2017), the U.S. Navy lacks a standardized and holistic way to track work/rest activity information to provide an objective assessment of human performance risk onboard ships. This shortcoming presents a large knowledge gap and a

missed opportunity to optimize work schedules, improve crew resource management, and gain insight on fatigue risk indicators. Fatigue risk indicators such as prolonged wakefulness and insufficient sleep are associated with increased human performance risks which can lead to major accidents during naval operations.

The SMART risk assessment tool was designed to allow users to visualize activity and risk trends to enable data-driven crew resource management decisions and implement targeted fatigue mitigation actions. While the current configuration is tailored for use onboard surface ships, it is scalable for use by various organizational types. The SMART tool also offers several wide-ranging applications such as analyzing the impact of changes to already strained operational schedules and individual workloads, reducing the human performance risk data gap, and enriching fatigue research models tailored to the military maritime environment. Moreover, the collected activity data can be used to clarify the disparity between the activity hours allocated versus the activity hours accomplished in manpower models to significantly influence manning decisions.

To improve crew endurance, warfighter performance, and operational effectiveness and safety, the U.S. Navy must invest in fatigue management tools and methods tailored to the military maritime environment. The surface combatant community must foster innovation and support cultural shifts aimed at decreasing the risk associated with degraded human performance. The SMART risk assessment tool is one effort to standardize data-driven human performance risk assessment.

II. SMART OVERVIEW

The Scheduling Management Aid for Risk Tracking (SMART) risk assessment tool was developed using Microsoft Excel. All the outputs rely on a mixture of PivotTables, PivotCharts, and some Visual Basic for Applications (VBA) code. The dynamic graphical user interface (GUI) allows users to quickly filter and find the information they need to make data-driven crew resource management decisions. Additionally, the built-in human performance risk heuristics provide users with the means to assess human performance risk associated with work and rest activity data. This chapter contains the conceptual design, development notes, organizational structure descriptions, and object attribute details for the risk assessment tool.

A. CONCEPTUAL DESIGN

The SMART tool tracks work and rest activity data and provides outputs designed to enable decision makers to better assess work/rest schedules, enhance crew resource management, and mitigate human performance risk related to fatigue. Figure 1 provides an overview of the SMART tool's inputs, constraints and limitations, and outputs. The main inputs are the activity information categorized as watch (W), work (A), maintenance (M), and sleep/rest (S) hours, in blue, for crew members (Figure 1). The main outputs are the graphical displays and reports, in orange, which provide schedulers and decision makers with human performance risk insights, in green (Figure 1).

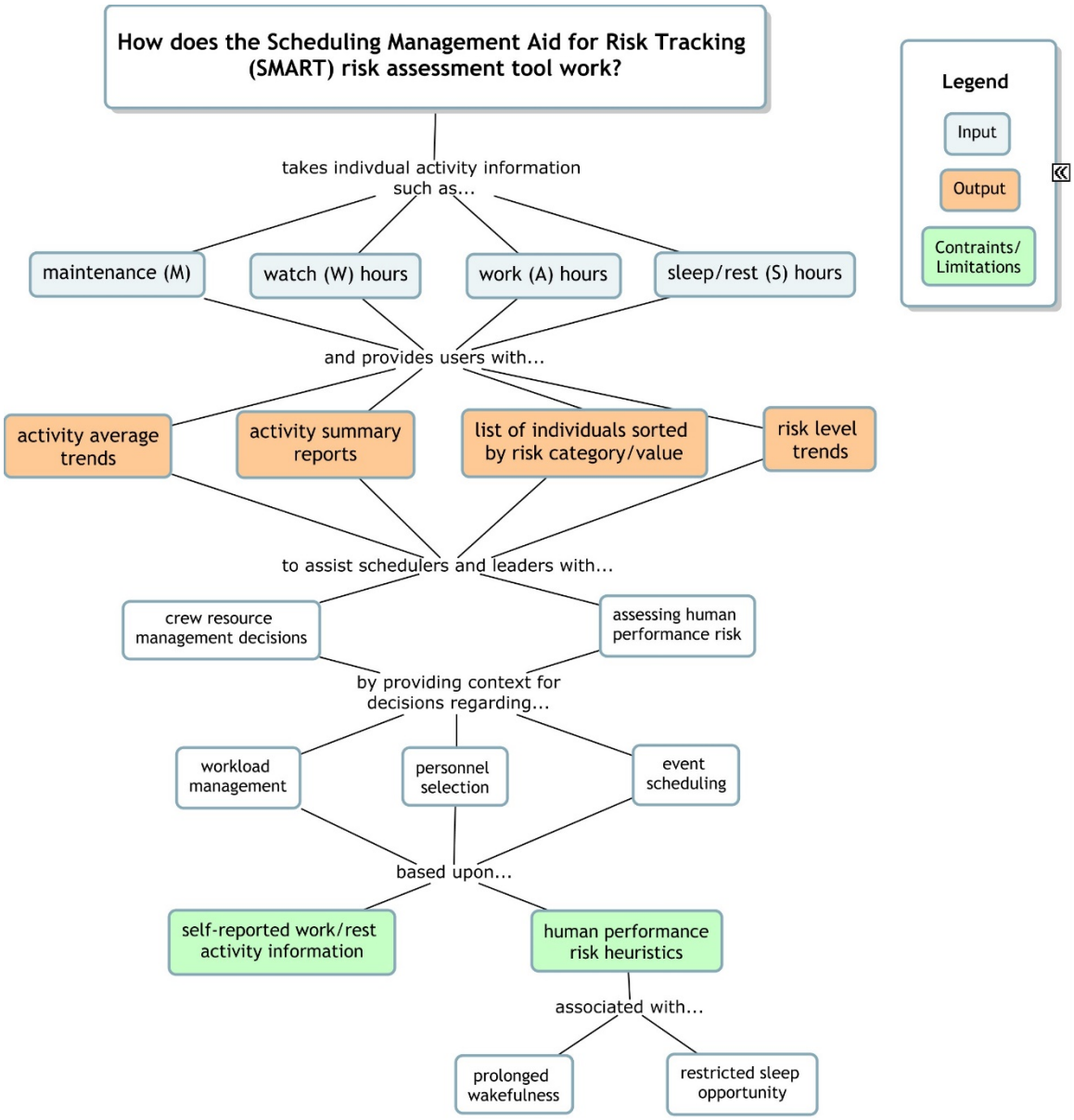
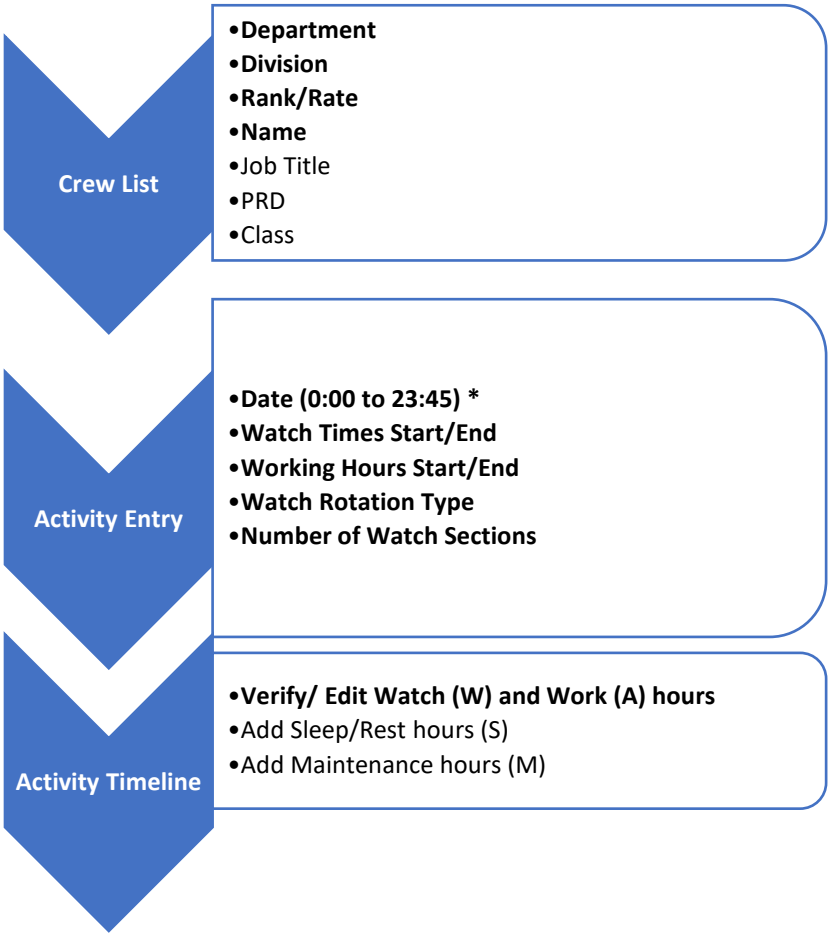


Figure 1. SMART Risk Assessment Tool Concept Map

The SMART tool contains two databases, one for personnel and one for work/rest activity. Figure 2 outlines the data entry process which begins with the entry of the crew member names and their organizational associations (e.g., Department, Division, Duty Section, etc.) in the Crew List tab. The Activity Entry tab is automatically populated with the personnel data from the Crew List tab which enables users to enter the individuals' watch and work times within a given day. Additional days for the same individual are

added in the same tab. The activity data from the Activity Entry tab automatically populates the respective 15-minute time blocks in the Activity Timeline tab. Users can verify and revise the watch and working hours in the Activity Timeline tab. Additionally, users can enter sleep/rest and maintenance activity in the Activity Timeline tab. The Activity Timeline also allows the user to filter the data to display the activity distribution by date, organizational level, or select crew members.



Bold text indicates required user inputs and regular text indicates optional data entry fields.

* The day ends at 23:45 to keep the 15-minute tracking pattern.

Figure 2. Diagram of Data Entry Process

After the data entry process is completed, the SMART tool automatically calculates descriptive statistics based on the human performance risk metrics listed in the Activity Thresholds tab. The descriptive statistics (e.g., average working hours and average sleep/rest hours) located in the Activity Summary tab enable data-driven crew resource management decision making and forms the foundation for the various dashboards within the tool.

B. ORGANIZATIONAL STRUCTURE

The SMART workbook contains several tabs. The Overview tab in the workbook contains summary information (e.g., name, purpose and available functions, and user notes) for the available tabs. Each tab name in the directory is directly linked to the associated tab for ease of navigation. The tabs visible to the user are marked in blue, and the hidden developer tabs are marked in red (Table 1). The developer tabs within the workbook contain PivotTables that are linked with the outputs displayed in the three dashboards: AverageActivity_DB, RiskList_DB, and RiskTrends_DB. Dashboard is abbreviated as "DB". The PivotTables were hidden to reduce the display of redundant information and reduce the likelihood of formatting changes or errors to the dashboard outputs.

Table 1. Organizational Structure of the SMART Risk Assessment Tool

Tabs visible to the user are shown in blue, and hidden developer tabs are shown in red.

Tab Name	Function(s)
Cover	Contains a copy of the report documentation page of the associated master's thesis.
Overview	Provides a navigational pane and overview of the available functions.
1_CrewList	Contains a list of all personnel along with their associated Department, Division, and Rank/Rate. This information will feed into the functionality of other tabs in the tool.
2_ActivityEntry	Allows users to enter an activity (e.g., watch and work) hours.
3_ActivityTimeline	Allows users to verify and edit watch and work activity information. The user can also enter maintenance and sleep/rest activity.

Tab Name	Function(s)
4_ActivitySummary	Contains summarized information for activity hours. Allows users to enter activity thresholds for assessment of human performance risk.
5_ThresholdValues	Displays the activity threshold limits, associated risk assessment values, and concern level ratings. The user can modify the activity threshold limits in this tab.
AverageActivity_DB	Provides graphical displays for activity averages (e.g., total work, watch, sleep/rest, and maintenance).
RiskList_DB	Provides a list of all personnel by risk level category (e.g., minor, moderate, serious, or critical).
RiskCharts_DB	Provides graphical displays sorted by risk level category (e.g., minor, moderate, serious, or critical).
ActivityAverages_OrgLevel	Contains the PivotTables for the activity averages graphics sorted by Department and Division utilized in the Average Activity Dashboard tab.
ActivityAverages_Trends	Contains the PivotTables for the activity averages trend graphic utilized in the Average Activity Dashboard tab.
RiskCharts	Contains the PivotTables for the risk level graphics utilized in the Risk Charts Dashboard tab.
Validation	Provides drop down item selections to aid in data validation.
Demographics	Provides demographic graphics from the Crew List tab.

1. Crew List Tab

The personnel database is contained in the Crew List tab and is formatted as a table to facilitate future development and ease of summary statistic tabulation. Table 2 details the field names, data types, and data descriptions for the entry fields in the Crew List tab. The Department, Division, and Class entry fields are data-validated, and the selection options are currently tailored for a Cruiser or Destroyer ship type organizational structure.

Table 2. Crew List Tab Field Names and Attributes

Bold field names are required SMART risk assessment tool inputs.

Field Name	Data Type	Data Description
Department	Text	Department abbreviation
Division	Text	Division abbreviation
Rank/Rate	Text	Rank (Officer)/ Rate (Enlisted) abbreviation
Name	Text	First and last name
Job Title	Text	Primary billet title

Class	Text	Officer or Enlisted classification
Projected Rotation Date (PRD)	Date/Time	Local date/time (minimum of month and year)

2. Activity Database

The Activity Database is comprised of the Activity Entry, Activity Timeline, and Activity Summary tabs. The activity tabs were designed to automatically populate with Department, Division, Rank/Rate, and Name data points from the Crew List tab. This function was designed to reduce the administrative burden on the user by eliminating the need to enter redundant information. The Activity Entry tab was designed to transfer data typically contained in a watchbill in a centralized location (Table 3). The watches were separated into two blocks because watchstanders commonly stand two watches during a 24-hour period. Working hours were meant to capture the individual's normal working hours (e.g., 0600 to 1600). Additional watch or work hours can be manually added under the Activity Timeline tab as required. While users can utilize additional or alternative activity codes like "T" for training, they will not be automatically tabulated in the Activity Summary table in the currently available version. Moreover, the outputs will not automatically reflect activities outside of the pre-programmed activity codes. If the user is interested in adding additional activity codes, please refer to the instructions in the Developer Features and Functions Chapter.

Table 3. Activity Entry Tab Field Names and Attributes

Field Name	Data Type	Data Description
Date	Date/Time	Formatted as MM/DD/YYYY
Watch Rotation Type	Text	Fixed or Rotating
Number of Watch Sections	Numeric	Total number of watch sections for the individual's watch station
Watch 1 Start	Time	Formatted as 00:00:00 AM in military time
Watch 1 End	Time	Formatted as 00:00:00 AM in military time
Watch 2 Start	Time	Formatted as 00:00:00 AM in military time
Watch 2 End	Time	Formatted as 00:00:00 AM in military time
Working Hours Start	Time	Formatted as 00:00:00 AM in military time
Working Hours End	Time	Formatted as 00:00:00 AM in military time

After the required inputs are entered in the Activity Entry tab, the watch (W) and work (A) activity blocks are automatically filled in the Activity Timeline tab. The collection form for the Activity Timeline is formatted in 15-minute time increments to account for staggered watch relief schemes common to most USN ships. There is a hierarchical structure for watch and work activities. In cases where working hours overlap with watch times, watch will take precedence because that is the Sailor's main priority. For example, if a Sailor has watch from 0600 to 0900 and normally works from 0600 to 1600, the 0600 to 0900 blocks will contain a "W" and the 0915 to 1600 blocks will contain an "A." The user can verify that the work/rest activity data is correct under the Activity Timeline tab and manually modify the information to account for watch/work changes. Users can also add Sleep/Rest and Maintenance activity data to the same tab.

Once the Activity Timeline tab is populated with work/rest activity data, the summary metrics are automatically calculated and displayed in the Activity Summary tab (Table 4). The Activity Summary Tab populates the pivot tables and charts in the SMART risk assessment tool's dashboards.

Table 4. Activity Summary Tab Field Names and Attributes

Field Name	Data Type	Data Source	Data Description
Watch (hours/day)	Numeric	Activity Timeline tab	Cumulative watch time from 00:00 to 23:45 in 15-minute increments
Sleep/Rest (hours/day)	Numeric	Activity Timeline tab	Cumulative sleep/rest time from 00:00 to 23:45 in 15-minute increments
Work (hours/day)	Numeric	Activity Timeline tab	Cumulative work time from 00:00 to 23:45 in 15-minute increments
Maintenance (hours/day)	Numeric	Activity Timeline tab	Cumulative maintenance time from 00:00 to 23:45 in 15-minute increments
Total Work Time (hours/day)	Numeric	Activity Summary tab	Sum of watch, work, and maintenance hours
Sleep/Rest Score	Numeric	Activity Summary tab	Integer values from 0 to 3
Work Period Score	Numeric	Activity Summary tab	Integer values from 0 to 3

Field Name	Data Type	Data Source	Data Description
Watch Rotation Score	Numeric	Activity Summary tab	Integer values from 0 to 1
Watch Section Number Score	Numeric	Activity Summary tab	Integer values from 0 to 2
Risk Value	Numeric	Activity Summary tab	Sum of the activity (sleep/rest, work, watch rotation, watch section number, and maintenance) scores
Risk Rating	Text	Activity Summary tab	Critical, Serious, Moderate, or Minor ratings based on the risk value

3. Dashboard Display and Reports

The dashboard displays and reports are the outputs for the SMART risk assessment tool. SMART contains three dashboards separated in the Average Activity, Risk Lists, and Risk Charts tabs. Table 5 contains the field names and attributes for the dashboard displays and reports from the risk assessment tool. The Activity Summary tab and associated dashboards are designed to update as the Activity Entry or Activity Timeline tabs are changed. The dynamic dashboard interfaces were designed to allow the user to quickly filter through the summarized data.

Table 5. Dashboard Displays and Reports Field Name and Attributes

Graphic Title	Graphic Type	Data Source	Notes
Activity Averages Trends	Line Chart	Activity Summary tab	Displays average activity hours trends by date. The user can filter the results by Date, Department, Division, and Name.
Activity Averages by Department	Column Charts	Activity Summary tab	Displays charts for work activities and sleep/rest time by Department. The user can filter the results by Date and Department.
Activity Averages by Division	Column Charts	Activity Summary	Displays charts for work activities and sleep/rest time by Department. The user can filter the results by Date, Department, and Division.

Graphic Title	Graphic Type	Data Source	Notes
Risk List Table	Pivot Table	Activity Summary tab	Displays a list of all individuals who fall under a specified risk rating or risk value. The user can filter the results by Date, risk rating, risk value, Department, and Division
Risk Level Trends	Line Chart	Activity Summary tab	Displays the number of individuals per risk rating category by date. The user can filter the results by Date, Department. Division, Risk Rating, and Name.
Risk Counts by Department	Column Charts	Activity Summary tab	Displays charts for the number of individuals by risk rating category. The user can filter the results by Date, Department, and Risk Rating.
Risk Counts by Division	Column Charts	Activity Summary tab	Displays charts for the number of critical and serious risk individuals by Division. The user can filter the results by Date, Department, Division, and Risk Rating.

C. DATA STRUCTURES

The personnel and activity data repositories are formatted as tables to enable quick tabulations and the use of PivotTables and PivotCharts. Overviews for the data structures are organized as follows: tables (Table 1), PivotTables (Table 2), and PivotCharts (Table 3).

Table 6. Table Data Structure Overview

Object Name	Location (tab)	Notes
CrewList_Table	1_CrewList	Includes names, ranks/rates, organizational affiliation, job title, classification type, and projected rotation date.
ActivityEntry_Table	2_ActivityEntry	Includes organizational affiliation, rank/rate, name, date, watch rotation type, number of watch sections, watch start/stop times, and work start/stop times.

Object Name	Location (tab)	Notes
ActivityTimeline_Table	3_ActivityTimeline	Includes organizational affiliation, rank/rate, name, date, and activity codes corresponding with 15-minute increment time blocks Note: Avoid including the times in the table reference because it will change the formatting structure and render the formulas ineffective.
ActivitySummary_Table	4_ActivitySummary	Includes organizational affiliation, rank/rate, name, date, activity summaries, risk value ratings, and risk values.
ThresholdLimits_Table	5_Thresholds	Includes activity threshold limits and risk assessment values. Light yellow cells are adjustable. Defined table name.
WorkLimits_Table	5_Thresholds	Includes risk rating categories and associated values in hours. Defined table name.
SleepLimits_Table	5_Thresholds	Includes risk rating categories and associated values in hours. Defined table name.
RiskLevel_Table	5_Thresholds	Includes risk level values and ratings. Defined table name.

Table 7. PivotTable Data Structure Overview

Object Name	Tab Location	Notes
AvgWorkTrends_PT	ActivityAverages_Trends (hidden)	Connected to Date timeline. Connected to Department, Division, and Name slicers.
AvgSleepTrends_PT	ActivityAverages_Trends (hidden)	Connected to Date timeline. Connected to Department, Division, and Name slicers.
AvgWorkbyDept_PT	ActivityAverage_OrgLevel (hidden)	Connected to Date timeline. Connected to Department and Division slicers.
AvgSleepbyDept_PT	ActivityAverage_OrgLevel (hidden)	Connected to Date timeline. Connected to Department and Division slicers.
AvgWorkbyDiv_PT	ActivityAverage_OrgLevel (hidden)	Connected to Date timeline. Connected to Department and Division slicers.

Object Name	Tab Location	Notes
AvgSleepbyDiv_PT	ActivityAverage_OrgLevel (hidden)	Connected to Date timeline. Connected to Department and Division slicers.
RiskList_PT	RiskList_DB	Connected to Date timeline. Connected to Department, Division, Risk Rating, Risk Value, and Name slicers.
RiskTrends_PT	RiskCharts (hidden)	Connected to Date timeline. Connected to Department, Division, and Name slicers.
RiskCountsbyDept_PT	RiskCharts (hidden)	Connected to Date timeline. Connected to Department and Division slicers.
RiskCountsbyDiv_PT	RiskCharts (hidden)	Connected to Date timeline. Connected to Department and Division slicers.

Table 8. PivotChart Data Structure Overview

Object Name	Tab Location	Notes
AvgWorkTrends_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department, Division, and Name slicers.
AvgSleepTrends_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department, Division, and Name slicers.
AvgWorkbyDept_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department and Division slicers.
AvgSleepbyDept_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department and Division slicers.
AvgWorkbyDiv_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department and Division slicers.
AvgSleepbyDiv_PC	AverageActivity_DB	Connected to Date timeline. Connected to Department and Division slicers.
RiskTrends_PC	RiskCharts_DB	Connected to Date timeline. Connected to Department, Division, and Name slicers.

Object Name	Tab Location	Notes
RiskCountsbyDept_PC	RiskCharts_DB	Connected to Date timeline. Connected to Department and Division slicers.
RiskCountsbyDiv_PC	RiskCharts_DB	Connected to Date timeline. Connected to Department and Division slicers.

D. DATA PROCESSING AND HANDLING

The SMART risk assessment tool is designed to perform the following data processing and handling actions:

- Automatically carry over the information from the personnel and activity databases for processing to reduce the user's data entry time.
- Delineate required and optional data fields to reduce the user's data entry time and administrative burden.
- Account for data gaps or missing entries.
- Automatically calculate summary statistics for work (e.g., watch, work, and maintenance) and rest activity data at different organizational levels (e.g., individual, division, and department) to produce graphical outputs and reports.

E. DATA OUTPUTS

The SMART risk assessment tool is designed to provide the following outputs based on the personnel and activity data entered:

- Work/rest activity summary reports sorted by organizational level for trend analysis.
- Average activity levels sorted by organizational level to assist with crew resource management decisions (e.g., personnel selection and work schedule management).

- Human performance risk rating trends to facilitate risk assessments.
- Lists the critical and serious risk crew members filtered by organizational affiliation to assist with implementing targeted risk mitigation actions.

F. DESIGN ASSUMPTIONS

The following design assumptions were used in the development of the SMART risk assessment tool:

- Sleep/rest activity times only indicate opportunities for sleep or rest.
- Individuals will fall under either a circadian (i.e., fixed) or non-circadian (i.e., rotating) rhythm-based watch rotation in a 24-hour period.
- Departures from the standard watch/work times (e.g., unplanned events or evolutions) entered in the Activity Entry tab will be remedied in the Activity Timeline tab.
- Sailors will not deviate from their scheduled watch times or will correct them in the Activity Timeline tab.
- Daily routines events such as cleaning stations, training, messing and berthing inspections, mealtimes, etc., will be captured under the period designated as Working Hours.

G. CRITERIA FOR RISK ASSESSMENT

The risk assessment criteria for the test scenarios were based on the Basic Risk Assessment Matrix (Table 9). In Table 9, probability refers to the frequency of occurrence over time. Severity is related to the effect of hazard. Risk assessment levels are categorized as Extremely High (EH) = 1, High (H) = 2, Medium (M) = 3, or Low (L) = 4. The *Operational Risk Management* instruction outlines the operational risk management (ORM) decision making process and explains the time versus non-time critical risk management processes (OPNAVINST 3500.39D, 2018). These criteria were chosen

because of the Department of the Navy's familiarity with the matrix and risk assessment process.

Table 9. Basic Risk Assessment Matrix. Adapted from OPNAVINST 3500.39D (2018).

Risk Assessment Matrix		**Probability**				
		Frequent (A)	**Likely (B)**	**Occasional (C)**	**Seldom (D)**	**Unlikely (E)**
Severity	Catastrophic (I)	EH (1)	EH (1)	H (2)	H (2)	M (3)
	Critical (II)	EH (1)	H (2)	H (2)	M (3)	L (4)
	Moderate (III)	H (2)	M (3)	M (3)	L (4)	L (4)
	Negligible (IV)	M (3)	L (4)	L (4)	L (4)	L (4)

For example, the risk (i.e., likelihood) of the ship running aground or colliding with another vessel during a high-risk Sea and Anchor evolution is increased when a watchstander is sleep-deprived. Similarly, a watchstander who is less alert may hurt themselves or cause damage to localized equipment if, for example, they inadvertently activate a fire suppression system or improperly shut down a running engine. Both situations require an assessment of risk and appropriate mitigating actions to lower the assessed risk to an acceptable level. Risk mitigation may be accomplished by stationing safety observers in strategic locations, employing props during drills and training events, or assessing watchstander readiness (e.g., fatigue, illness, or injury) prior to assuming the watch especially during high-risk evolutions.

The framework behind the work/rest activity data risk score assignment is comparable to the method by which the Individual Risk Management (IRM) code is assigned. The overall work/rest activity data risk score, referred to as the Concern Level in the prototype, is the sum of risk assessment values for various categories. Metrics from the service members' activity data are collected and roughly categorized based on the activity thresholds outlined in the *CFEMP (2017)* and the IRM Tool (IRMT). Activity limits were selected after combining elements from the policy and the IRMT. The combination allowed for less ambiguity compared to strictly adopting the IRMT Watch to Rest Ratio limits. Moreover, the combination accommodated stratified risk assessment ratings compared to

strictly adopting the *CFEMP* limits. The metrics, criteria, and risk assessment values are outlined in Table 10. The activity thresholds were based on existing DON guidelines, which directly apply to U.S. Navy warships. Moreover, the human performance risk metrics associated with insufficient sleep and excessive workloads are supported by years of crew endurance and fatigue research and are known contributors to degraded Sailor productivity and warfighting capacity.

Table 10. Criterion and Risk Assessment Value

Risk Metrics	**Criterion (in a 24-hour period)**	**Risk Assessment Value**
Sleep/Rest Period Length	Sleep/Rest hours ≤ 3	3
	3 < Sleep/Rest hours ≤ 5	2
	5 < Sleep/Rest hours < 7	1
	Sleep/Rest hours ≥ 7	0
Total Work Period Length	Work hours ≤ 8	0
	8 < Work hours ≤ 12	1
	12 < Work hours < 16	2
	Work hours ≥ 16	3
Watch Rotation Type	Fixed	0
	Rotating	1
Number of Watch Sections	Watch Sections ≤ 2	2
	Watch Sections = 3	1
	Watch Sections ≥ 4	0

The final risk level values/ ratings outlined in Table 11 are based on the sum of the sleep/rest period length, total work period length, number of watch sections, and watch rotation type risk assessment values. During a 24-hour period, if a Sailor had a 6-hour sleep/rest period, a 14-hour work period, a fixed watch, and a four section watch rotation, the Sailor would receive risk assessment values of 1, 2, 0, and 0, respectively (Table 10). As a result, the Sailor would receive a Risk Level score of 3 or Moderate (Table 11). Low Concern Levels values are ideal and indicate little to no additional risk due to human performance; high numbers indicate higher human performance risk associated with the work/rest activity data from the individual. The activity threshold and risk assessment values are adjustable in the prototype to account for policy changes or to accommodate a

ship's unique operational schedule. Sailors onboard a ship operating in Condition III underway steaming configuration will have a different work/rest activity pattern compared to Sailors operating under Condition I or General Quarters. The difference in operational schedules and tasking would translate to a different risk tolerance and warrant adjustments to the Risk Level ratings.

Table 11. Risk Level Values and Ratings

Values	Rating
8 +	Critical
5 - 7	Serious
2 - 4	Moderate
0 - 1	Minor/Negligible

H. ORGANIZATIONAL LEVEL CONFIGURATION

The SMART risk assessment tool is currently configured to handle a crew size roughly equivalent to a guided missile destroyer (DDG) or guided missile cruiser (CG). Table 12 contains a summary of the departments, divisions, and rates associated with the data-validation rules. Officers are not explicitly listed in Table 12 because they span the departments and divisions.

Table 12. Department, Division or Work Center, and Rates Summary

Department	Division	Rates
Combat Systems (CS)	CC	IT
	CE	ET & IC
	CF	FCA
Engineering (ENG)	EA	MM
	EE	EM
	ER	DC, HT, & FN
	MP	GSE, GSM, & GS
Executive/Navigation (EXEC/NAV)	EX	MA, NC, PS, RP, & YN
	HM	HM
	NN	QM
Operations (OPS)	OD	BM & SN
	OI	OS

Plans and Tactics (PT)	CA	STG
	OT	CTT, CTR, & IS
Supply (SUP)	S1	LS
	S2	CS
	S3	SH
Weapons (WEPS)	CG	GM
	CM	FC

III. SMART FUNCTIONS

This chapter contains some user functions for the SMART risk assessment tool. At its current state, SMART does not provide recommendations for limiting human performance risk or staying within recommended activity thresholds. However, it provides users with several benefits. First, users can record and process activity information in a holistic way. Previously, there was no widely available approach to account for man-hours, outside of maintenance tracking, at an individual or organizational level. SMART's outputs provide users with insight into the crew's workloads, enabling proactive scheduling and more effective crew resource management decision making. Moreover, SMART provides users with the ability to assess human performance risk associated with work/rest activity, enabling intuitive and targeted risk mitigation practices.

A. DEMOGRAPHICS COLLECTION

Users can create a chart detailing the distribution of officers and enlisted personnel by department (Figure 3) or division (Figure 4). The abbreviated departments and divisions for the following figures were based on the organizational structure introduced in Table 12. The department designations are as follows: Combat Systems (CS), Engineering (ENG), Operations (OPS), Supply (SUP), Executive/Navigation (EXEC/NAV), and Planning and Tactics (PT). The department and division names can be adjusted, as needed.

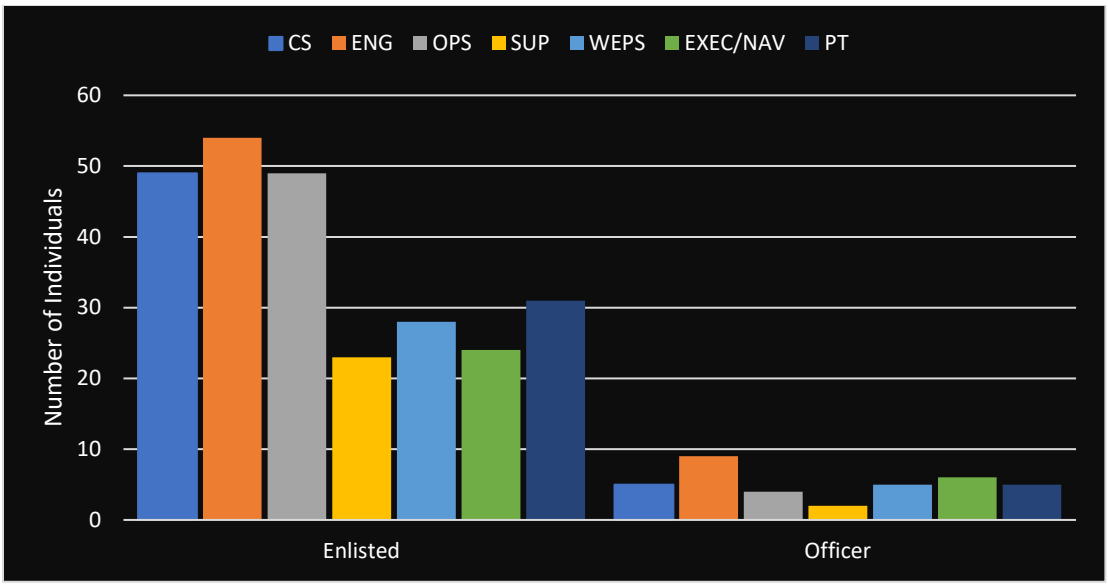


Figure 3. Distribution of Officers and Enlisted Personnel by Department

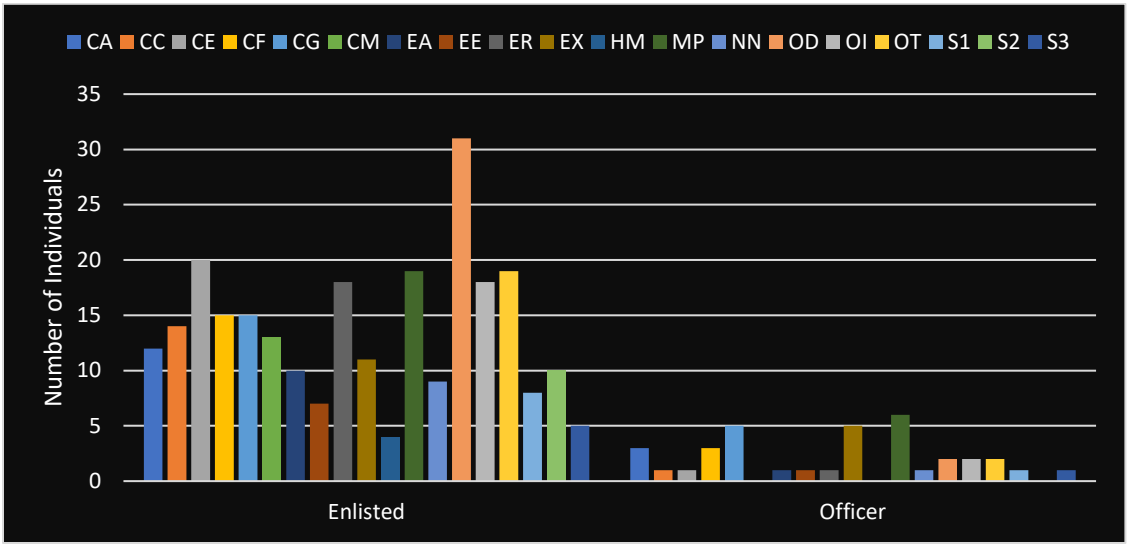


Figure 4. Distribution of Officers and Enlisted Personnel by Division

B. DASHBOARD OUTPUTS

Users can filter their dashboard results by risk type and value, organizational level, and time (Figure 5). The Date timeline filter can be adjusted to cover specific periods of interest. Multiple departments or divisions can be selected for analysis if the user selects the "multi-select" icon at the top right-hand corner of each slicer (Figure 5). Activity and

risk trend charts can also be filtered by searching for one or multiple individuals by name. The data entry and verification process can be simplified by using the filters on the headers of all columns.

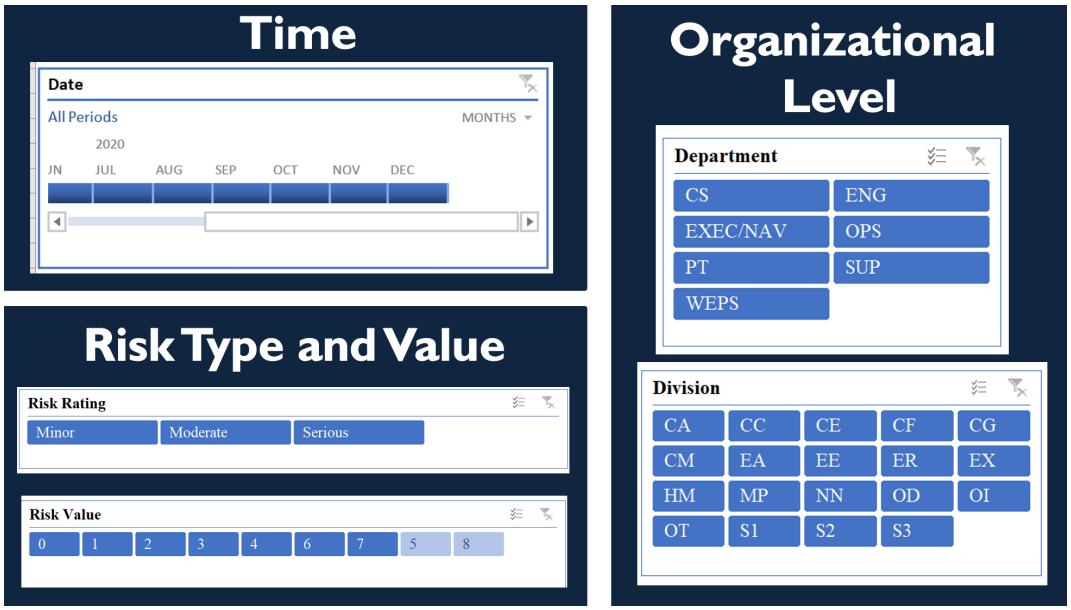


Figure 5. Three Main Dashboard Filters

Figures 6 through 15 are sample outputs from SMART's three dashboards. The red, orange, yellow, and green dashed lines visually reinforce the corresponding activity thresholds as listed in Table 10. Each color follows the risk rating color scheme outlined in Table 11: red (critical), orange (serious), yellow (moderate), and green (minor/negligible). The total work time, as indicated by the purple squares, are the summation of watch, maintenance, and work activity categories (Figure 6). The user can see how total work hours for the entire study period hover around 12 hours which is associated with a moderate human performance risk rating (Figure 6). Figure 7 shows a sample output of the Average Sleep/Rest Activity Trends. The provided example showed that crew members averaged between five to seven hours of sleep with minor fluctuations during the study period, which is associated with serious to moderate human performance risk, respectively (Figure 7).

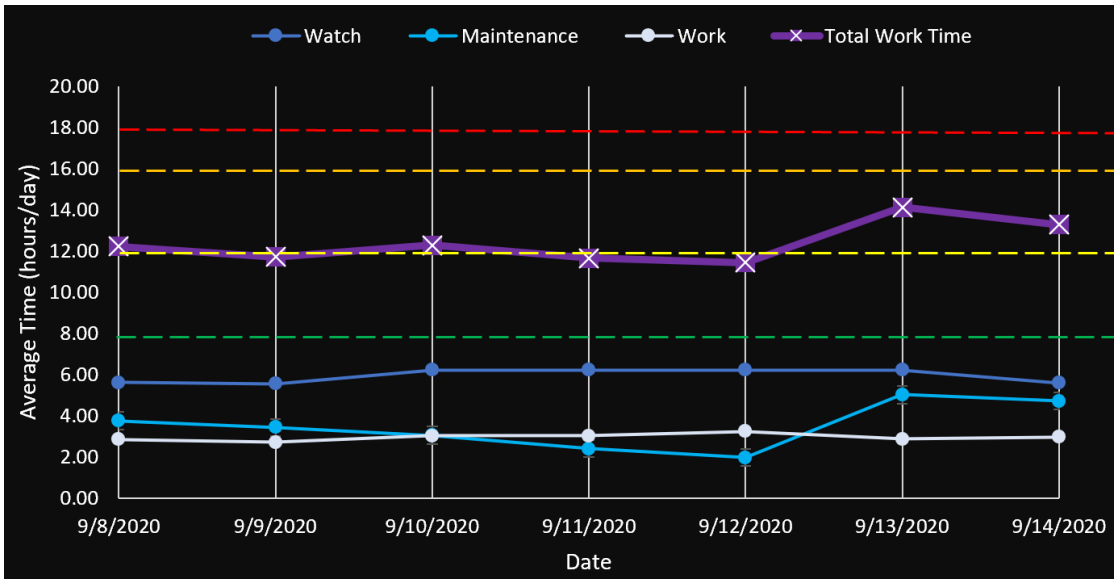


Figure 6. Average Work Activity Trends

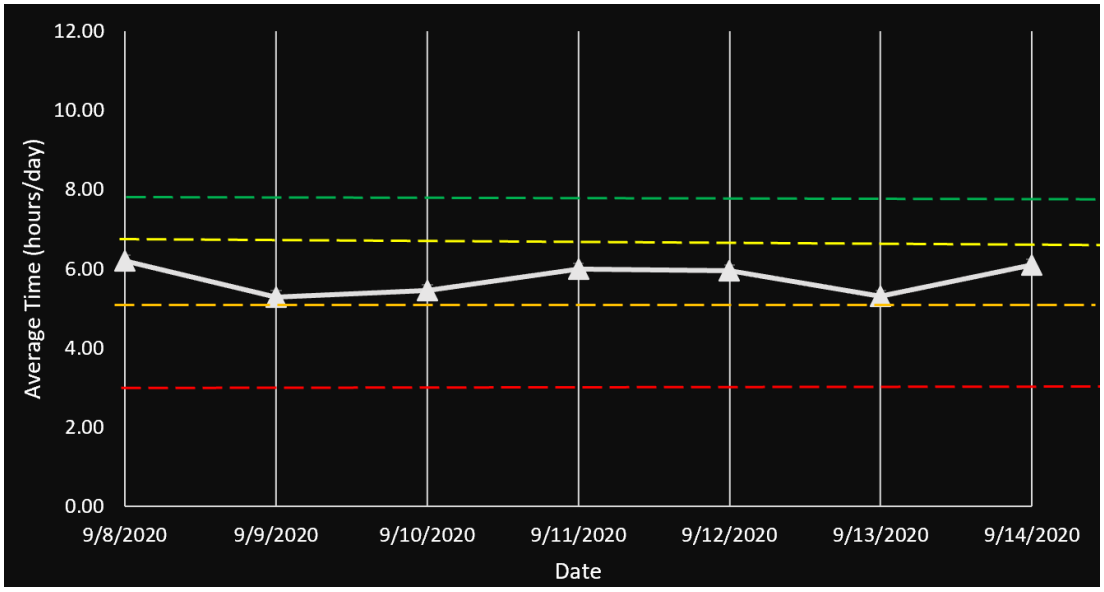


Figure 7. Average Sleep/Rest Activity Trends

Figures 8 and 9 detail the average work activities by department and division. The error bars displayed on Figures 8 and 9 were based on the following standard error formula: Standard Error = Standard Deviation(Sampling Range) / Square Root(Count(Sampling Range)). Users are able to discern differences in the distribution of work activity averages

between departments (Figure 8) and divisions (Figure 9) to measure how a Sailor's organizational affiliation can influence how much and what type of work they will perform.

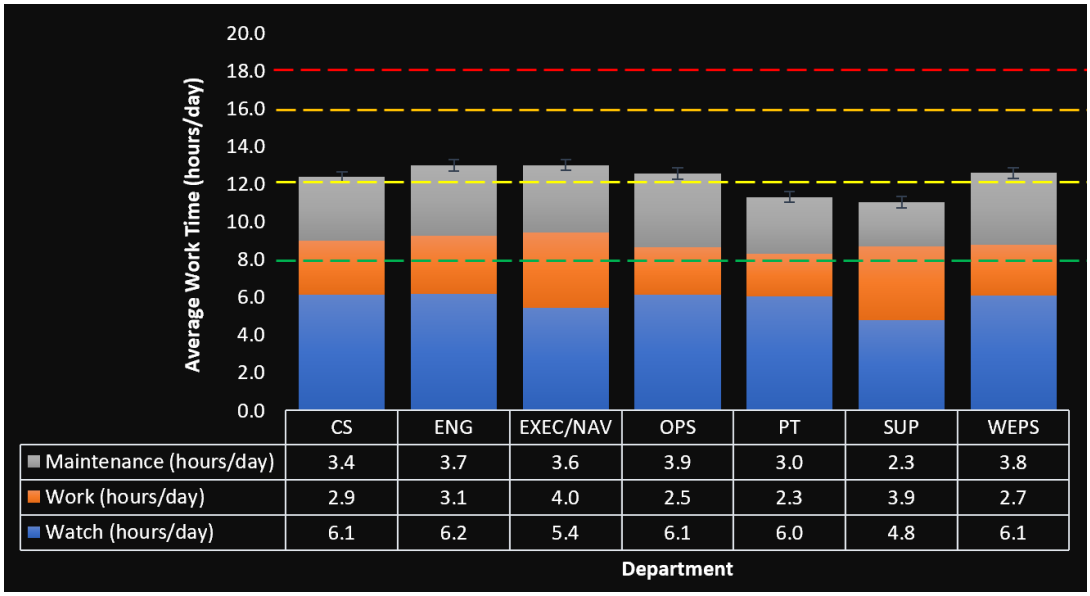


Figure 8. Average Work Activity Times by Department

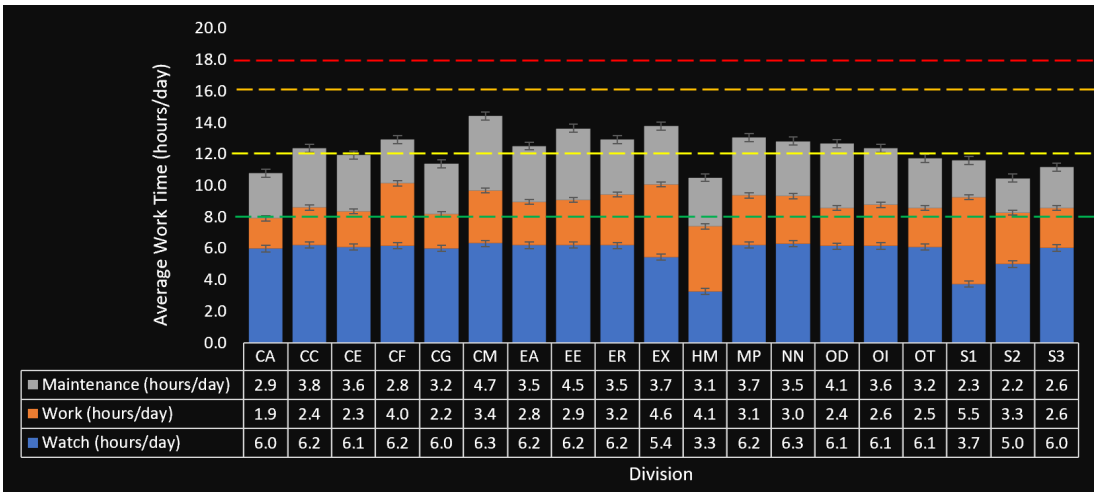


Figure 9. Average Work Activity Times by Division

Users are able to measure average sleep/rest times by department (Figures 10) and division (Figure 11). The examples provided show that all departments and divisions fell below the National Sleep Foundation's recommended threshold of eight hours of sleep

(Figures 10 and 11). Although the sleep/rest times do not speak to the quality of sleep or whether the individual was sleeping or just allotted time to sleep/rest, the data-driven graphics can emphasize the chronic problem of inadequate sleep. Insights from these outputs provide leaders with the ability to pinpoint departments or divisions suffering from high workloads and insufficient sleep/rest time. Leaders can then implement targeted crew resource management mitigations such as increasing training opportunities to produce more qualified personnel or requesting permanent or temporary personnel augmentation to reduce the strain of excessive workloads.

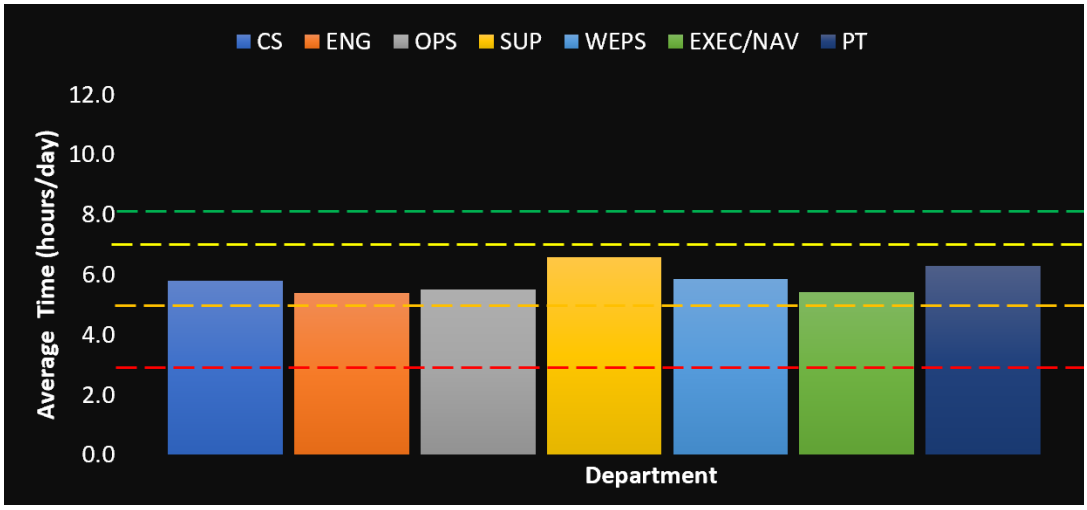


Figure 10. Average Sleep/Rest Time by Department

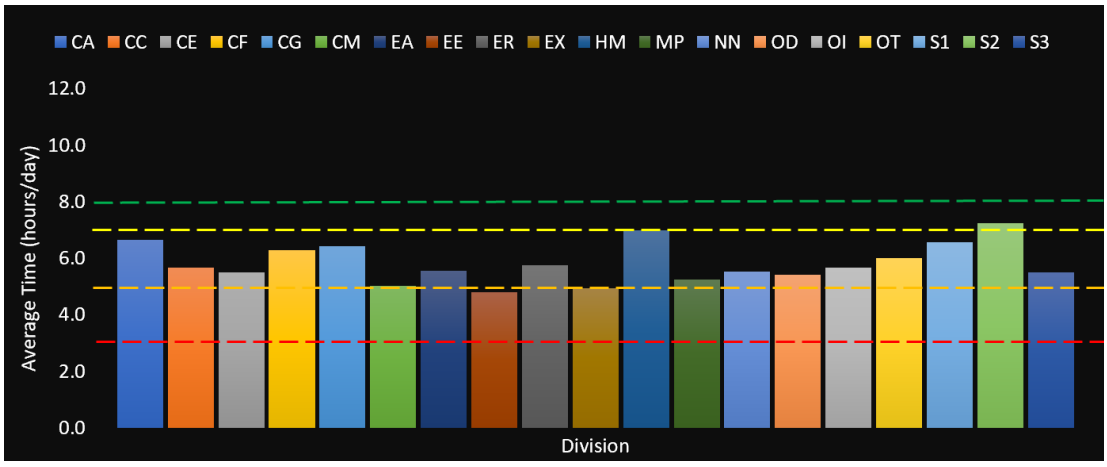
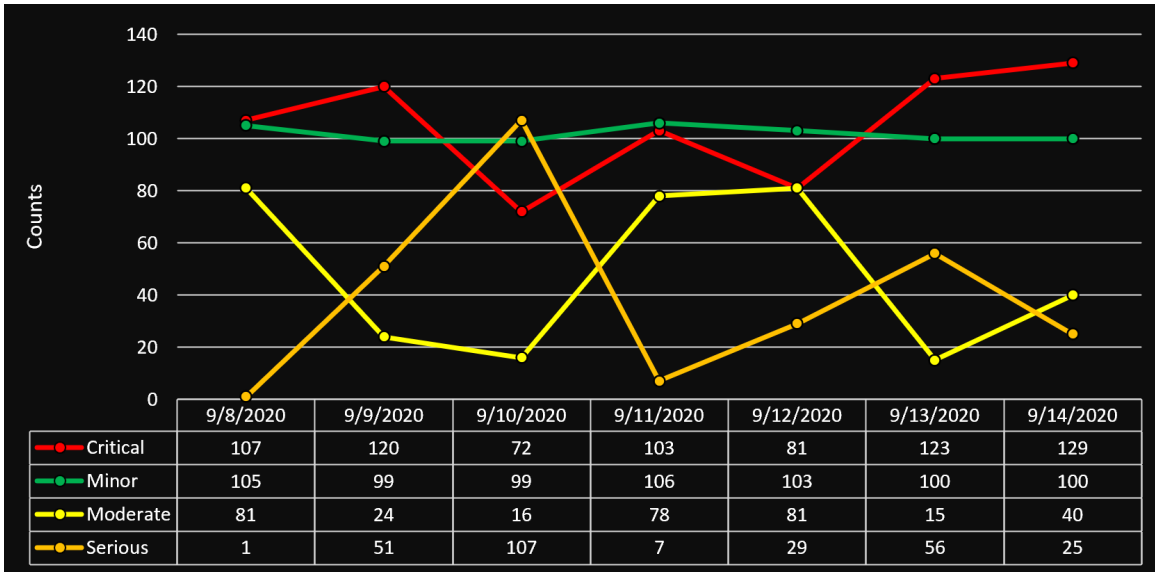


Figure 11. Average Sleep/Rest Time by Division

Lastly, the human performance risk outputs give a sense of the magnitude and degree of change in human performance risk over time (Figure 12). The SMART tool also provides users with the ability to create a list of personnel based on their risk level rating and value sorted by date and organizational affiliation (Figure 13). Figure 14 shows the number of individuals by risk rating category based on their organizational level. The insight gained from these outputs facilitates greater understanding about the human performance risk trends. Moreover, the categorization and quantification of risk enables leaders to implement targeted human performance risk reduction actions.



	9/8/2020	9/9/2020	9/10/2020	9/11/2020	9/12/2020	9/13/2020	9/14/2020
Critical	107	120	72	103	81	123	129
Minor	105	99	99	106	103	100	100
Moderate	81	24	16	78	81	15	40
Serious	1	51	107	7	29	56	25

Figure 12. Risk Level Trends

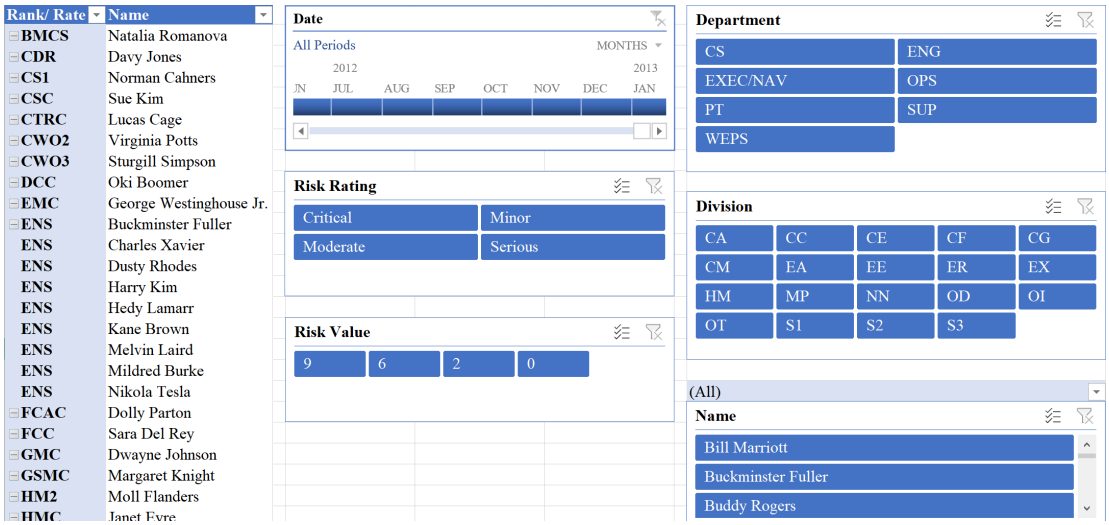


Figure 13. Risk List Output and Filters

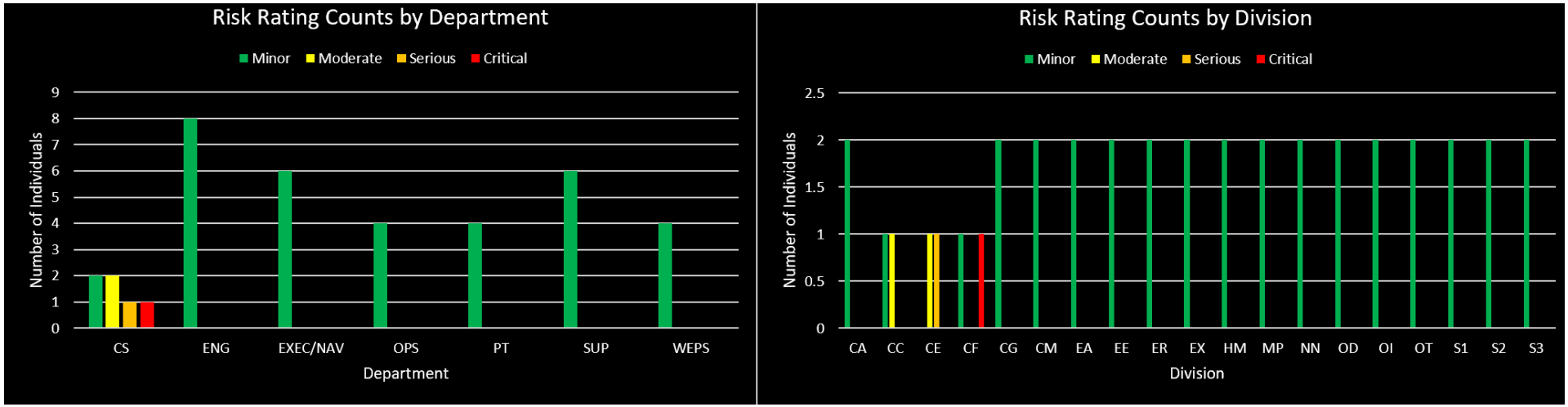


Figure 14. Risk Rating Counts by Department (left) and Division (right)

C. SENSITIVITY COMPARISON

The SMART prototype's initial results demonstrated its ability to process and display activity trends and human performance risk metrics. While the tool provides helpful information for assessing risk and managing crew resources, it is not without its limitations. The prototype's ability to illustrate the differences in magnitude for the best-case and worst-case individuals requires some refinement. Unless the user filtered their results appropriately, they may not see these troubling spikes in total work times.

The SMART prototype was also not particularly sensitive to the extremely high and extremely low levels of sleep/rest opportunities between the best and worst-case groups, respectively (Figure 15). One of the most concerning observations was that the worst-case group averaged three or fewer hours of sleep/rest time during the entire data collection period (Figure 15). Despite the shocking trend of many individuals operating in the red, there were no instances where the average dipped below five hours in the initial output (Figure 15). The eight or greater hours of sleep/rest time from the best-case group dampened the prototype's ability to reflect the increased risk the worst-case group was experiencing. Interestingly, the activity average oscillations observed within the mixed-case group output are reflected in the initial output as seen in the dips on September 9th, 10th, and 13th (Figure 15).

The SMART prototype's average metric may provide misleading results, especially in cases where comparatively equal proportions of the crew are operating on extremes of the activity spectrum. This sensitivity limitation demonstrates that great care should always be taken when interpreting these results. Fortunately, users have the ability to analyze the summarized results in the Activity Summary tab to provide additional context to the average activity outputs. While individuals operating in the serious or critical risk categories may not be readily apparent in the activity trends outputs, they are easily identifiable in the Risk List and Risk Charts tabs. Users are not only able to track the number of people at each risk category (Figure 16), but they are also able to filter that information based on organizational level (e.g., department, division, or individual) and identify specific individuals based on their risk value or risk category rating.

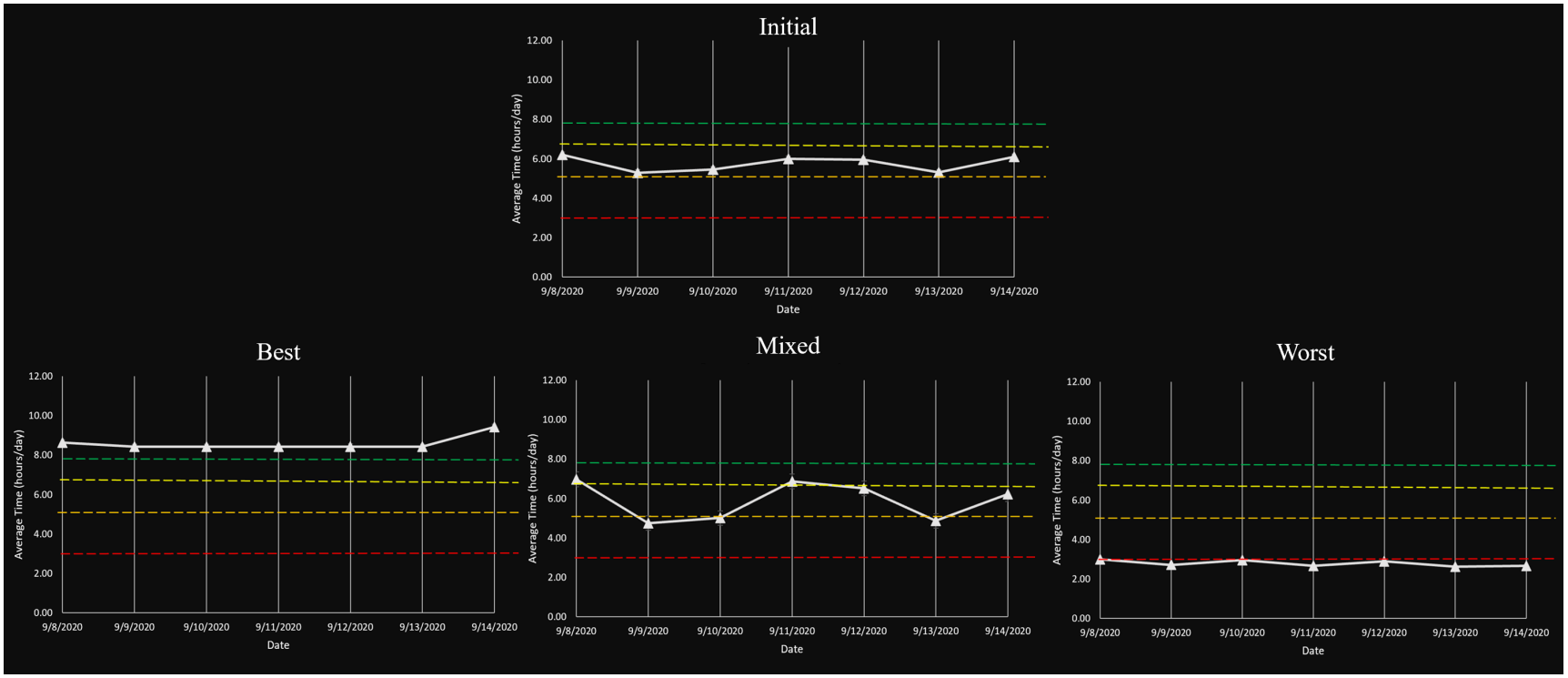


Figure 15. Case Comparisons for Average Sleep/Rest Activity Trends

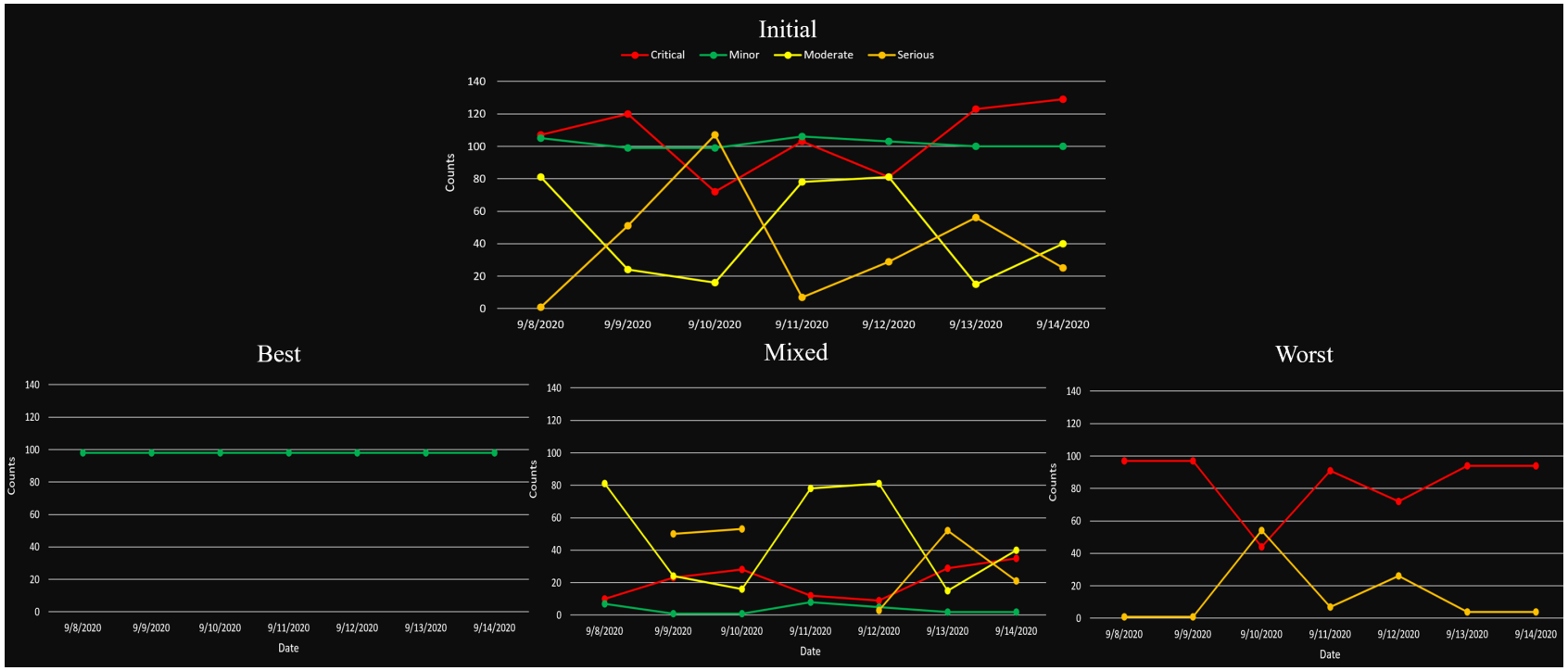


Figure 16. Case Comparisons of Human Performance Risk Trends

D. OUTPUT TO SPECIFIED SCENARIOS

The following section contains outputs and insights based on illustrative examples. These examples walk users through three practical applications for the SMART risk assessment tool.

1. Sea and Anchor Watchbill Human Performance Risk Assessment

The Sea and Anchor (S & A) watchbill assessment involves the review of several prototype outputs and scheduling considerations. For the prototype evaluation purposes, the user will be the Operations Officer (OPSO), a department head, looking to assess the human performance risk within a proposed inbound S & A watchbill scheduled for September 14th. OPSO would select the period of interest, September 8-13, and Operations Department (Figure 17). September 14th was excluded because the data has yet to be populated for the purposes of this scenario. The OD and OI divisions will be automatically selected since they belong to the Operations Department (Figure 17).

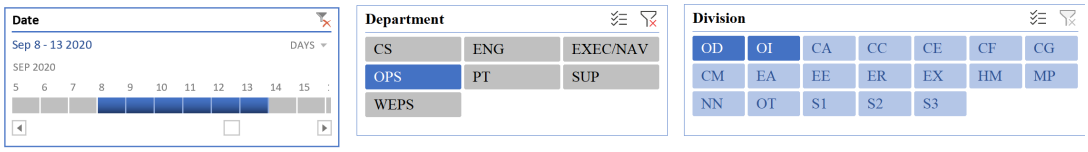
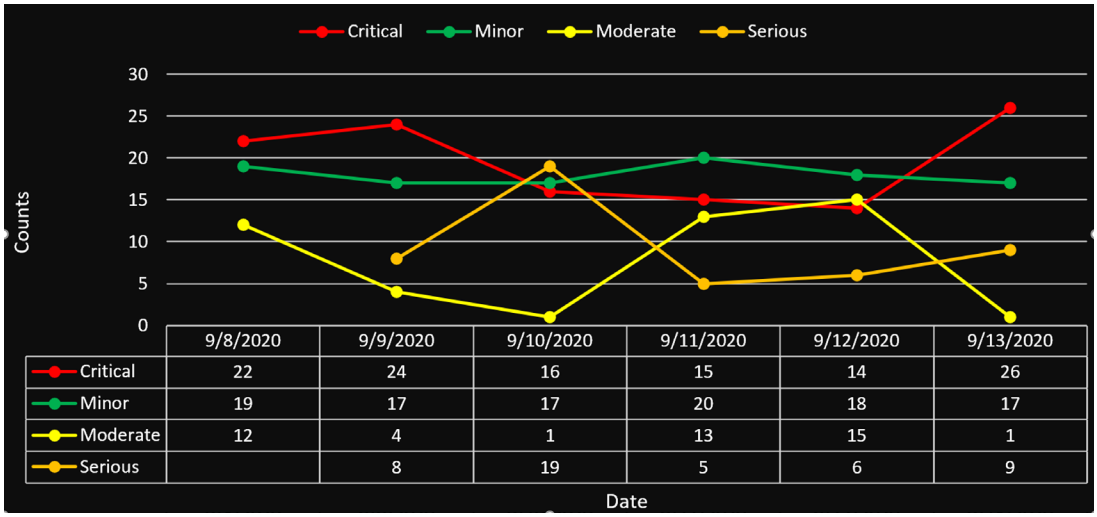


Figure 17. Operations Department Filter Selections for Sea and Anchor Watchbill Evaluation

The resulting outputs, Figures 18 through 20, can provide the user with several insights to base their watchbill evaluation upon. Figure 18 shows that there are 26 critical, 9 serious, 1 moderate, and 17 minor risk departmental personnel listed under September 13th, one day prior to the high-risk S & A evolution. OPSO can find the names of all critical risk individuals to compare against the departmental personnel listed on the proposed watchbill to assess how many personnel may require intervention (Figure 19). The moderate (yellow) and serious (orange) human performance risk associated with the department's activity data fluctuated greatly throughout the data collection period (Figure 20). While the numbers of minor (green) risk individuals remained comparatively steady,

the number of critical (red) risk individuals spike on September 13th (Figure 20). This is an especially concerning trend for the OPSO to note since many of his or her Sailors are involved in this evolution. Members from the OD division are particularly susceptible to more serious physical injuries due to their proximity to heavy equipment or tensioned lines during the S & A evolution.

Based on that risk information displayed by the prototype, OPSO can implement several interventions to mitigate human performance risk for his or her personnel. Three possible interventions would be to adjust the Sailor's schedule to include more time for rest prior to the following day's evolution, assign another safety observer at that particular watch station location, or to substitute the critical risk watch stander with another qualified lower-risk individual. The latter intervention is facilitated by the minor risk filtered list prototype output from the Risk List dashboard, which shows 17 potential candidates for substitution (Figure 20). OPSO can also view the departmental average activity trends to add context to their human performance risk assessment.



	9/8/2020	9/9/2020	9/10/2020	9/11/2020	9/12/2020	9/13/2020
Critical	22	24	16	15	14	26
Minor	19	17	17	20	18	17
Moderate	12	4	1	13	15	1
Serious		8	19	5	6	9

Figure 18. Operations Department Filtered Risk Level Trends from September 8-13, 2020

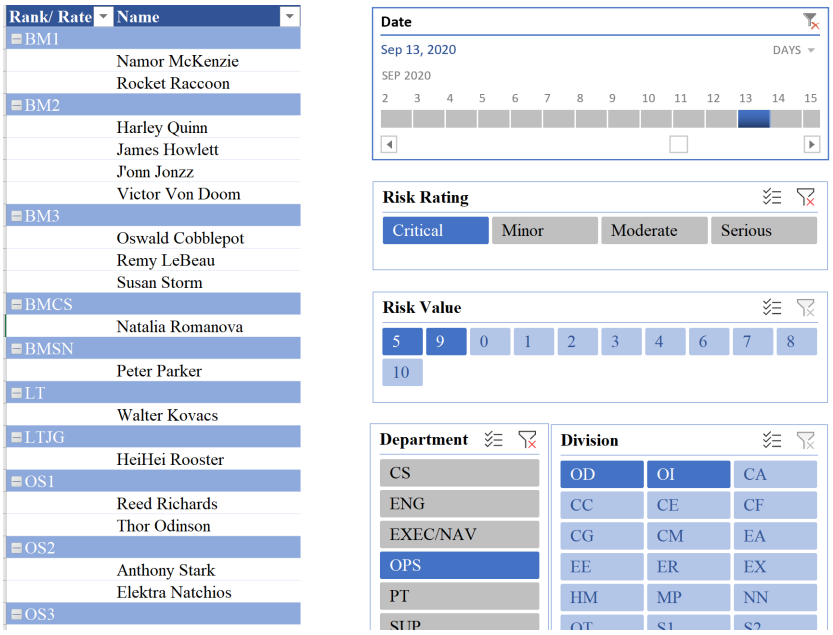


Figure 19. Critical Risk Listing of Operations Department Individuals from September 13th

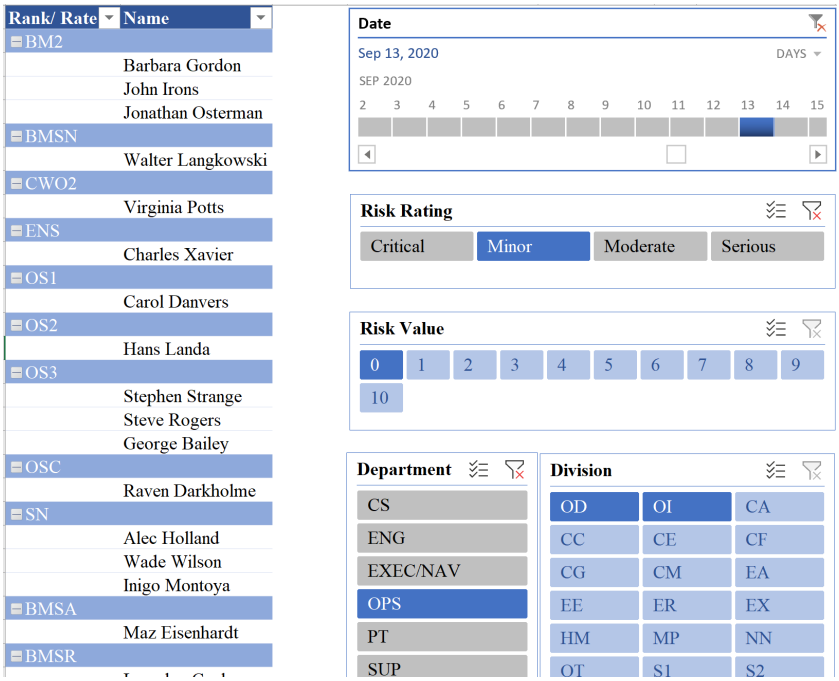


Figure 20. Minor/Negligible Risk Listing of Operations Department Individuals from September 13th

2. Divisional Activity and Human Performance Risk Assessments

For the next example, the users will be the divisional leadership of the CM division. The Strike Officer (STRIKE) leads the CM division which is comprised of Fire Control Technicians (FCs). FCs operate and maintain the Tactical Tomahawk Weapons Systems integral to supporting Strike Warfare (STW) missions. The divisional leadership's goals are to perform an activity time review and human performance risk assessment for their entire division spanning the whole study period (Table 13). First, the users would select the period of interest, September 8-14, 2020, and the CM division from the available filters. The resulting outputs, Figures 21 through 25 can provide the users with useful information to base their assessments on.

Table 13. Weapons Department CM Division Members

Rank/Rate	Name	Job Title	Type
ENS	Mildred Burke	STRIKE	Officer
FCC	Sara Del Rey	LCPO	Enlisted
FC1	Jake Roberts	LPO	Enlisted
FC1	John Cena	WCS	Enlisted
FC2	Akira Hokuto		Enlisted
FC2	Mickie Foley		Enlisted
FC2	Shawn Michaels		Enlisted
FC3	Chris Jericho		Enlisted
FC1	Judy Grable		Enlisted
FC1	Kurt Angle		Enlisted
FC2	Randy Savage		Enlisted
FC1	Ima Sailor		Enlisted
FC2	Davy Jones		Enlisted
FC3	Ono Goose		Enlisted

Figure 21 shows that the division averaged 12 hours of total work with a noticeable spike in maintenance hours on September 13th. This increase may be associated with a faulty system requiring repair or greater than normal periodic maintenance requirements. A Work Center Supervisor (WCS) can utilize the information from Figures 21 and 22 to better inform their maintenance planning schedules in the future by distributing maintenance hours more evenly throughout the work week. A comparison of work activity

averages shows that the CM division completes more maintenance and work hours when compared to another Weapons Department division (Figure 22). This observation may be useful in determining the proportion of divisional personnel that should be allocated for work details or for the assignment of additional tasking.

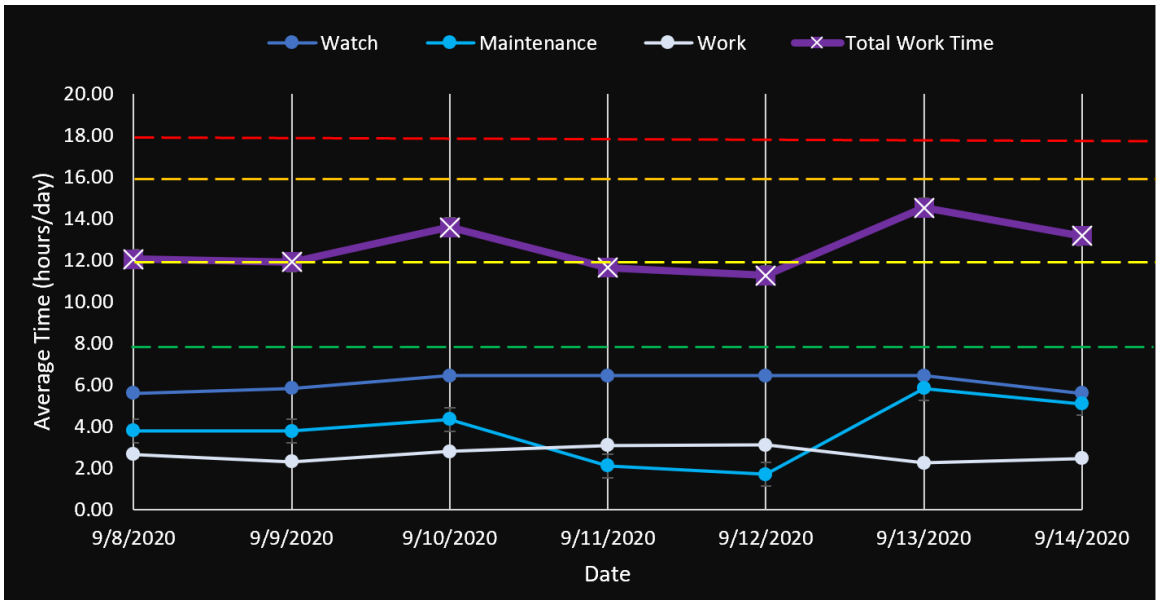


Figure 21. CM Division Filtered Risk Work Activity Trends from September 8-14, 2020

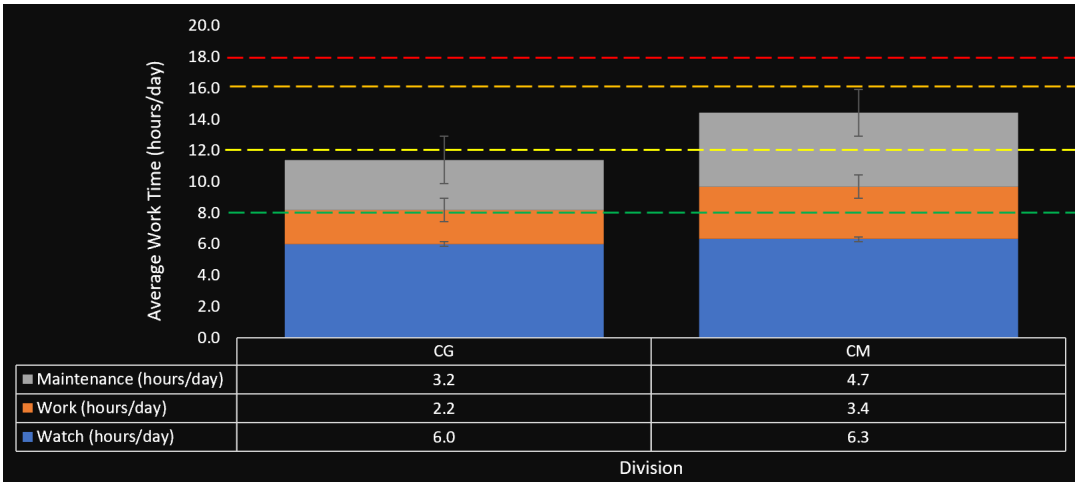


Figure 22. Weapons Department Filtered Average Work Activity Times

The CM division appears to be getting consistent amounts of sleep/rest opportunities but is still operating below the recommended NSF standard of eight hours (Figure 23). Additionally, the CM division is consistently getting less sleep/rest opportunities, approximately one hour less, when compared to CG division (Figure 24). Research has shown that operating at sustained levels of sleep debt has detrimental effects on human performance and increases human performance risk (Shattuck et al., 2014; Shattuck & Matsangas, 2016; Belenky et al., 2003). A significant proportion of the division was assessed as operating at critical to moderate risk, with large fluctuations in risk levels, throughout the data collection period (Figure 25). Divisional leadership can use this information to implement steps to increase sleep/rest opportunities for their Sailors to mitigate for these human performance risks.

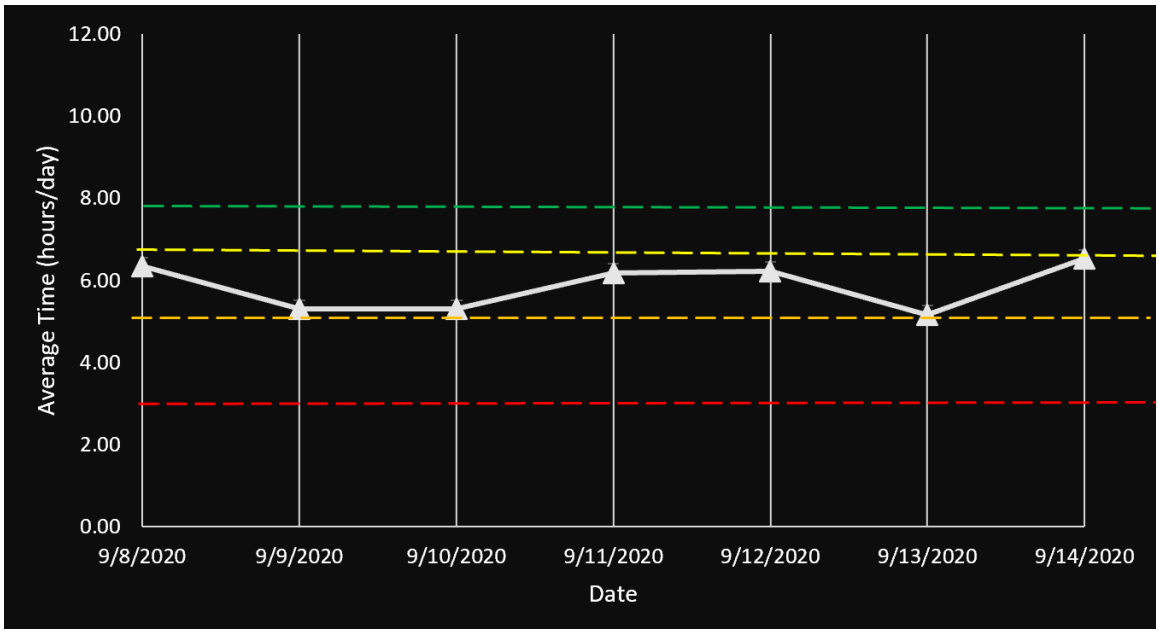


Figure 23. CM Division Filtered Risk Sleep/Rest Activity Trends from September 8-14, 2020

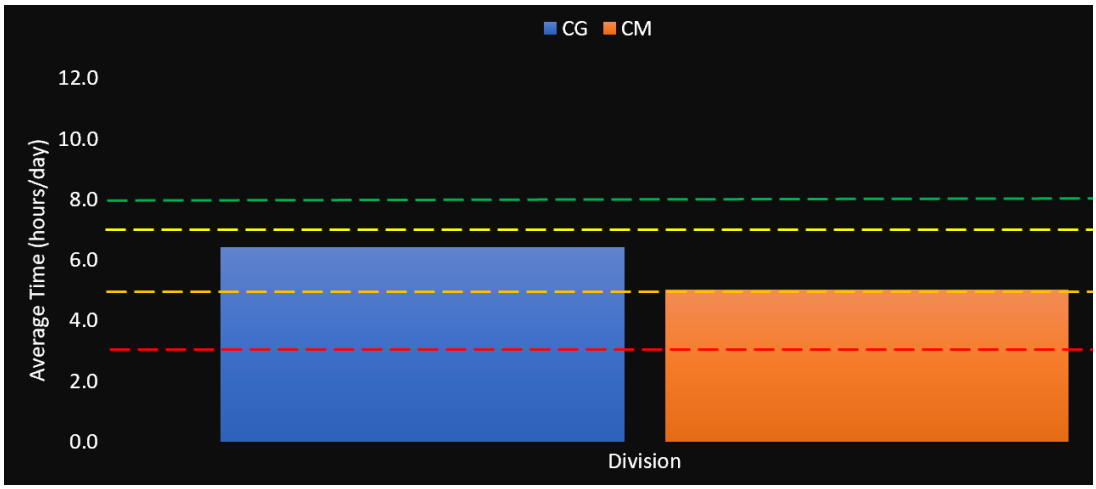
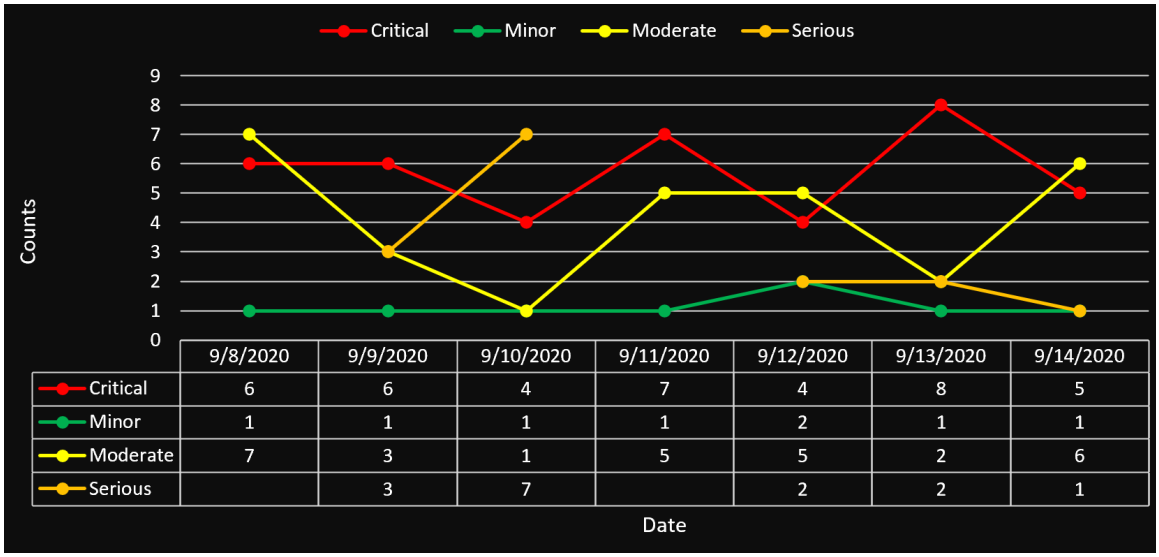


Figure 24. Weapons Department Filtered Average Sleep/Rest Activity Times



	9/8/2020	9/9/2020	9/10/2020	9/11/2020	9/12/2020	9/13/2020	9/14/2020
Critical	6	6	4	7	4	8	5
Minor	1	1	1	1	2	1	1
Moderate	7	3	1	5	5	2	6
Serious		3	7		2	2	1

Figure 25. CM Division Filtered Risk Level Trends

3. Critical Billet Holder and Individual Tracking

The next scenario is a human performance risk and readiness evaluation of a Search and Rescue (SAR) swimmer, a critical billet holder. Ships are required to have "properly equipped Search and Rescue Swimmers" (DON, 2011, p. 2). Failing to meet the requirement of having two SAR swimmers onboard is considered a redline, defined as a "personnel or equipment standard that must be met before a ship can safely get or remain underway" (DON, 2011, p. 2). While decision makers considered factors such as the

currency of the SAR swimmer's qualification and their demonstrated proficiency, they did not have a way of assessing human performance risk based on their historical activity data.

First, the user filters their selection for a specific individual, such as the fictional character of Harley Quinn (Figure 26). The dynamic nature of the prototype's filter selections automatically shows the individual's organizational affiliation, Operations Department in OD division (Figure 26). The Sailor's work and sleep/rest activity averages wildly fluctuate throughout the data collection period (Figures 26). The work activity averages ranged from 11 to 18-hour total workdays where the Sailor worked three, 18-hour days during the week (Figure 26). While the Sailor averaged six hours of sleep/rest opportunity for the week, it was largely inconsistent and prone to substantial downturns or upticks (Figure 26). The erratic activity patterns elevated the Sailor's human performance risk scores to critical on September 9th and 13th; both days coincided with high total work hours and low sleep/rest hours (Figure 27). There could have been substantial risk involved if the SAR swimmer were deployed for a rescue mission during those two days. Risks could include injury to the SAR swimmer, potential loss of a critical billet holder, or the failure to safely rescue someone. With the information presented by the SMART prototype, users would be made aware of those potential risks. Decision makers could then make data-driven and risk-informed decisions like deploying the other rescue swimmer if needed.

For the last example, a Chief Petty Officer (Chief) wants to nominate Ima Sailor for an award while collecting inputs for their Sailor's evaluation report. Activity summaries for Ima Sailor show that she worked an average of 15.36 hours during the week and worked three 18-hour days (Figure 28). Those three days may have coincided with emergent repairs for a critical system or her taking on extra maintenance responsibilities which would be positive points. The review also revealed Ima Sailor's chronic pattern of inadequate sleep, three or fewer hours per day (Figure 28) and consistent operation in the critical risk zone (Figure 29). Now that the Chief is aware of that information, he or she can work with their Sailor to ensure adequate rest opportunities and find ways to reduce their workload.

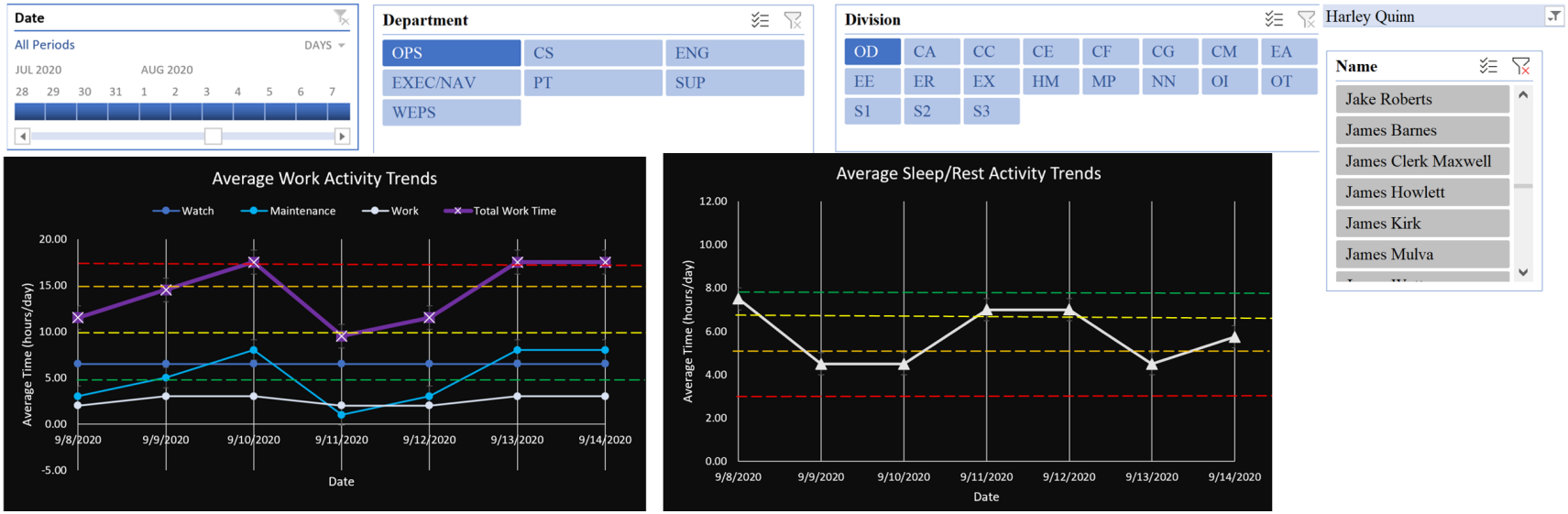


Figure 26. Average Activity Dashboard for the Search and Rescue Swimmer

0	9/8/2020	9/9/2020	9/10/2020	9/11/2020	9/12/2020	9/13/2020	9/14/2020
Critical		1				1	
Minor	1			1	1		
Moderate							1
Serious			1				

Date

Figure 27. Risk Rating Trends for Search and Rescue Swimmer

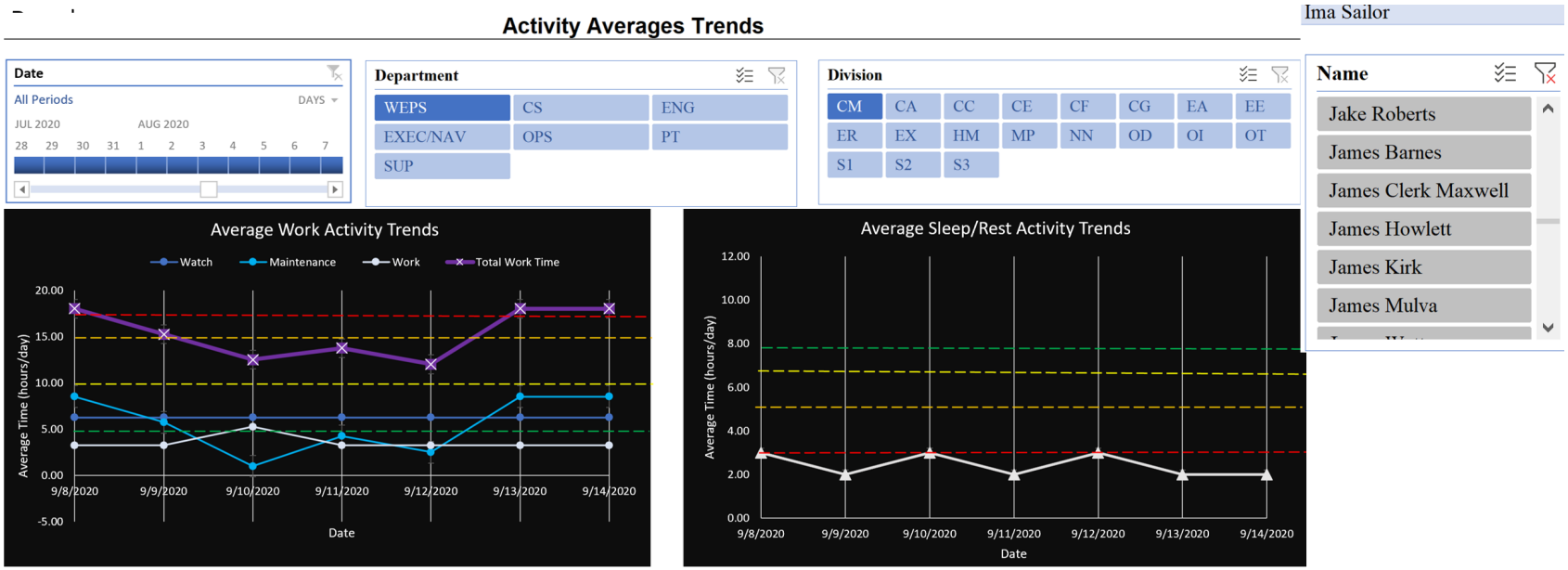


Figure 28. Average Activity Trends Dashboard for Individual Tracking

	9/8/2020	9/9/2020	9/10/2020	9/11/2020	9/12/2020	9/13/2020	9/14/2020
Critical	1	1	1	1		1	1
Serious					1		
	Date						

Figure 29. Risk Rating Trends for Individual Tracking

Despite the use of notional data for analysis, the SMART prototype demonstrated the capability of highlighting and quantifying human performance risk associated with work/rest activity data. While the SMART tool does not provide explicit recommendations for reducing risk, it begins to bridge the gap between intuitive and data-driven decision making. The illustrative examples were just a sampling of insights that could be gleaned from utilizing this prototype. The SMART tool showcased tangible ways to support the warfighter through data-driven decision making and risk management.

IV. SMART OPERATING INSTRUCTIONS

This section contains instructions for initializing and utilizing the SMART tool. A quick reference guide is available in Chapter VI. Additionally, there is a short video tutorial available through the Naval Postgraduate School Dudley Knox Library.

A. INITIAL USE CONFIGURATION

1. Download and open the **SMART_Template.xlsm** file.
2. Once the file is open, click **File** and **Save as**. Browse for a location to save your new file and name your document.

> ***NOTE***
>
> Using **Save as** ensures that the template is available in case the working file is corrupted.
>
> Click the **0_Overview** tab at the bottom of the workbook to familiarize yourself with the available functions and features.
>
> Sample data points are available in the template. Users should modify the fields, as necessary.

3. Click the **1_CrewList** tab. Enter the information under the required fields (e.g., Department, Division, Rank/Rate, and Name).

> ***NOTE***
>
> Individuals should only have one associated entry. Users can create, delete, modify, and search for crew members under this tab.
>
> After the members' data are entered, ensure that the entire field is formatted as a **Table** by selecting "**Ctrl + T**" and a "┘" symbol should appear at the bottom-right cell of the table.

4. Click the **2_ActivityEntry** tab. Enter information under the required fields (e.g., Date, Watch Rotation Type, Number of Watch Sections, Watch Start/End times, and Working Hours Start/End times).

WARNING

Do not leave the Watch Start/End and Working Hours Start/End times blank. If the individual does not have Watch or Working Hours for the day, enter "**N/A**" in the applicable cells.

5. Additional individual entries can be accomplished by copying the desired data from columns A through D (Department through Name) and pasting it after the last entry of the table in the **2_ActivityEntry** tab. Adjust the other required fields as necessary.

NOTE

The earliest and latest time entries for a 24-hour period are 0:00 and 23:59, respectively. Times in between 23:45 and 23:59 will be accounted for in the 23:45 activity block.

6. Click the **3_ActivityTimeline** tab. Verify that the watch and work times are accurately reflected in the timeline.

NOTE

Ensure to drag down the formatting cells in the **3_ActivityTimeline** tab to reflect all names and dates from the **2_ActivityEntry** tab.

7. Enter sleep/rest (S) and maintenance (M) activity blocks under the appropriate times, as necessary.

8. Click the **4_ActivitySummary** tab. Verify that the summarized activity times are accurate.

NOTE

Ensure to drag down the formatting cells in the **4_ActivitySummary** tab to reflect all the names and dates from the **3_ActivityTimeline**.

9. Click the **5_Thresholds** tab. Default activity limits are pre-populated.

NOTE

Adjusting default values is not recommended. Only default values in the pale-yellow cells may be adjusted.

10. Click the **AverageActivity_DB** tab. Use the available slicers to filter the results, as desired.

NOTE

Enable the **Multi-Select** functionality by clicking the multiple checklist icon on any of the slicers.

11. Click the **RiskLists_DB** tab. Use the available slicers to filter the results, as desired.

12. Click the **RiskCharts_DB** tab. Use the available slicers to filter the results, as desired.

B. UPDATING DATA

1. If changes are made to any of the tables or data fields, ensure all new/changed data fields are included within the new table and carried over on all subsequent tables.

NOTE

New/modified data entries must be in the correct format to be accounted for properly. Table 15 contains the formatting information for the data fields.

2. Check for a ┘ symbol at the bottom right-hand side of the table.

NOTE

If the ┘ symbol is not present, select the entire table (**Ctrl + A**), type "**Convert to Range"** in the search bar, and select the option. To return the selection back in to a table press **Ctrl + T**.

3. After data entry is complete, go to the ribbon, click **Data,** and click **Refresh All**.

C. FORMULAS AND FORMATTING

In case the formulas are erased or corrupted, Table 14 contains the formulas, columns, and reference cells. Users can then copy and paste the formula in the reference cell and then drag the formula down and/or across to complete the rest of the table. Table 15 contains

Table 14. Formula Table

Tab	Column	Formula	Reference Cell
1_CrewList	Class (F)	=IF(SUMPRODUCT(--([@[Rank/Rate]]=OfficerRanks))>0, "Officer", "Enlisted")	F2
2_ActivityEntry	Department (A)	=CrewList_Table[@Department]	A2
2_ActivityEntry	Division (B)	=CrewList_Table[@Division]	B2
2_ActivityEntry	Rank/Rate (C)	=CrewList_Table[@[Rank/Rate]]	C2
2_ActivityEntry	Name (D)	=CrewList_Table[@Name]	D2
3_ActivityTimeline	Department (A)	=ActivityEntry_Table[@Department]	A2
3_ActivityTimeline	Division (B)	= ActivityEntry_Table[@Division]	B2
3_ActivityTimeline	Rank/Rate (C)	= ActivityEntry_Table[@[Rank/Rate]]	C2
3_ActivityTimeline	Name (D)	= ActivityEntry_Table[@Name]	D2
3_ActivityTimeline	Date (E)	= ActivityEntry_Table[@Date]	E2
3_ActivityTimeline	Time (F – CW)	=IF(OR(AND('2_ActivityEntry'!$H2<=F$1,'2_ActivityEntry'!$I2>=F$1),	F2

		AND('2_ActivityEntry'!$J2<=F$1,'2_ActivityEntry'!$K2>=F$1)),"W", IF(AND('2_ActivityEntry'!$L2<=F$1,'2_ActivityEntry'!$M2>=F$1),"A",""))	
4_ActivitySummary	Department (A)	=ActivityTimeline_Table[@Department]	A2
4_ActivitySummary	Division (B)	=ActivityTimeline_Table [@Division]	B2
4_ActivitySummary	Rank/Rate (C)	=ActivityTimeline_Table[@[Rank/Rate]]	C2
4_ActivitySummary	Name (D)	=ActivityTimeline_Table [@Name]	D2
4_ActivitySummary	Date (E)	=ActivityTimeline_Table [@Date]	E2
4_ActivitySummary	Watch (F)	=((COUNTIF('3_ActivityTimeline'!F2:CW2,"W"))*15)/60	F2
4_ActivitySummary	Sleep (G)	=((COUNTIF('3_ActivityTimeline'!F2:CW2,"S"))*15)/60	G2
4_ActivitySummary	Work (H)	=((COUNTIF('3_ActivityTimeline'!F2:CW2,"A"))*15)/60	H2
4_ActivitySummary	Maintenance (I)	=((COUNTIF('3_ActivityTimeline'!F2:CW2,"M"))*15)/60	I2
4_ActivitySummary	Total Work Time (J)	=SUM([@[Watch (hours/day)]],[@[Work (hours/day)]],[@[Maintenance (hours/day)]])	J2
4_ActivitySummary	Sleep/Rest Score (K)	=IF(COUNTIF('3_ActivityTimeline'!F2:CW2,"S"),IF(G2<='5_Thresholds'!$E$5,3,IF(AND(G2>'5_Thresholds'!$A$6,G2<='5_Thresholds'!$E$6),2,IF(AND(G2>'5_Threshol	K2

		ds'!$A$7,G2<'5_Thresholds'!$E$7),1,0))),"Blank")	
4_ActivitySummary	Work Period Score (L)	=IF(COUNTIF(J2,"<>0"),IF(J2<='5_Thresholds'!$E$10,0, IF(AND(J2>'5_Thresholds'!$A$11,J2<='5_Thresholds'!$E$11),1, IF(AND(J2>'5_Thresholds'!$A$12,J2<'5_Thresholds'!$E$12),2, 3))),"Blank")	L2
4_ActivitySummary	Watch Rotation Score (M)	=IF(ISBLANK('2_ActivityEntry'!F2),"Blank", IF('2_ActivityEntry'!F2="Rotating", 1, 0))	M2
4_ActivitySummary	Watch Section Number Score (N)	=IF(ISBLANK('2_ActivityEntry'!G2),"Blank", IF('2_ActivityEntry'!G2<=2,2, IF('2_ActivityEntry'!G2>=4,0,1)))	N2
4_ActivitySummary	Risk Value (O)	=SUM(K2:N2)	O2
4_ActivitySummary	Risk Rating (P)	=IF(O2<=1, "Minor", IF(AND(O2>=2,O2<=4), "Moderate", IF(AND(O2>5,O2<=7), "Serious", "Critical")))	P2

Table 15. Formatting Table

Column Name	Format	Data-Validated
Department	Text	Yes
Division	Text	Yes
Rank/Rate	Text	Yes

Job Title	Text	No
Class	Text	No
PRD	Date (Mon-YY)	No
Date	Date (*M/DD/YYY)	No
Watch Rotation Type	Text	Yes
Number of Watch Sections	Number	No
Watch # Start/End	Time (HH:MM)	No
Work Start/End	Time (HH:MM)	No
Activity Timeline Times	Time (HH:MM)	No
Watch (hours/day)	Number	No
Sleep (hours/day)	Number	No
Work (hours/day)	Number	No
Maintenance (hours/day)	Number	No
Total Work Time (hours/day)	Number	No
Sleep Rest Score	Number	No
Work Period Score	Number	No
Watch Rotation Score	Number	No
Watch Section Number Score	Number	No
Risk Value	Number	No
Risk Rating	Text	No

V. DEVELOPER FEATURES AND FUNCTIONS

This section contains instructions on how to modify the template outputs.

A. ADD ANOTHER ORGANIZATIONAL LEVEL

To add another organizational level for use within the template, perform the following steps:

1. Create a new column in the **1_CrewList** tab by right clicking in the area shown and selecting **Insert** from the drop-down menu (Figure 30). Add a column title and units such as "Work Center" in the header section.

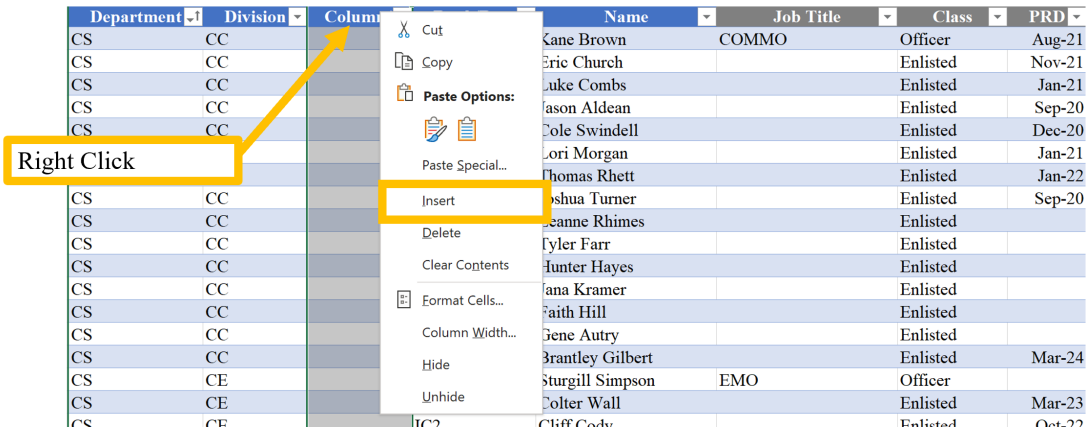


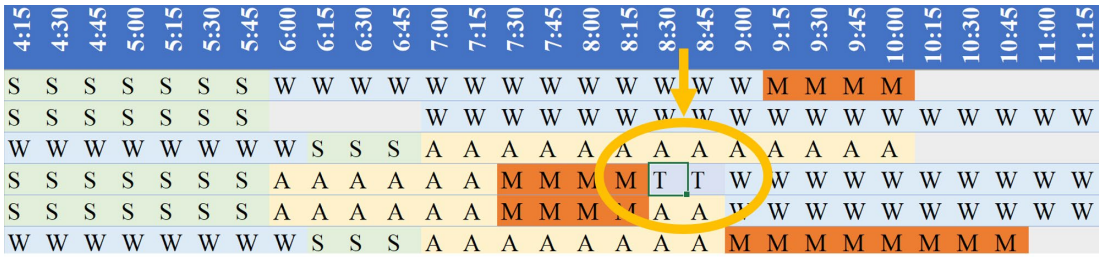
Figure 30. Insert New Column for Another Organizational Level

2. Add the new column in the **2_ActivityEntry**, **3_ActivityTimeline**, and **4_ActivitySummary** tabs, preferably in the same location.

B. ADD ANOTHER ACTIVITY

To prepare another activity code for use within the template, perform the following steps:

3. Select a new code such as "T" for training and use it in the **3_ActivityTimeline** tab (Figure 31).



4:15	4:30	4:45	5:00	5:15	5:30	5:45	6:00	6:15	6:30	6:45	7:00	7:15	7:30	7:45	8:00	8:15	8:30	8:45	9:00	9:15	9:30	9:45	10:00	10:15	10:30	10:45	11:00	11:15
S	S	S	S	S	S	S	W	W	W	W	W	W	W	W	W	W	W	W	W	M	M	M	M					
S	S	S	S	S	S	S					W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
W	W	W	W	W	W	W	W	S	S	S	A	A	A	A	A	A	A	A	A	A	A	A	A					
S	S	S	S	S	S	S	A	A	A	A	A	A	M	M	M	M	T	T	W	W	W	W	W	W	W	W	W	W
S	S	S	S	S	S	S	A	A	A	A	A	A	M	M	M	M	A	A	W	W	W	W	W	W	W	W	W	W
W	W	W	W	W	W	W	W	S	S	S	A	A	A	A	A	A	A	A	M	M	M	M	M	M	M	M		

Figure 31. New Activity Code Addition in the **3_ActivityTimeline** tab

4. Create a new column in the **4_ActivitySummary** tab by right clicking in the area shown and selecting **Insert** from the drop-down menu (Figure 32). Add a column title and units such as "Training (hours/day)" in the header section.

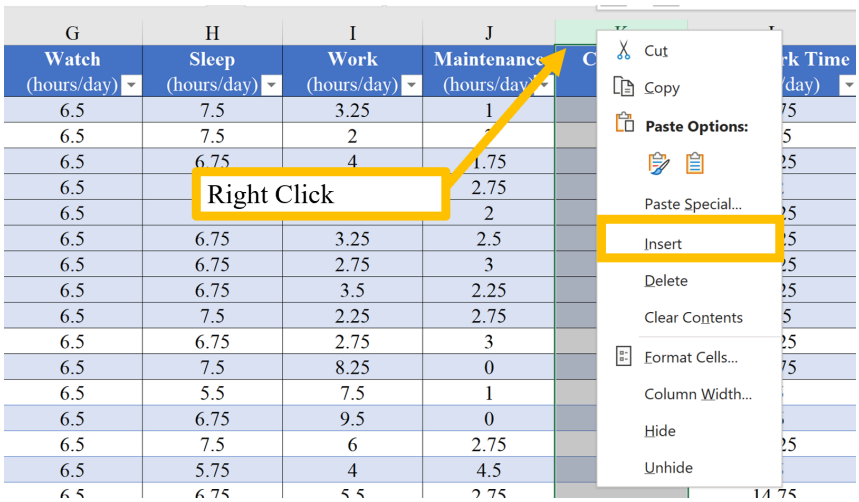


Figure 32. Insert Activity Summary Column in the **4_ActivitySummary** tab

5. Enter the following formula "=((COUNTIF('3_ActivityTimeline'!G2:CX2,"T"))*15)/60" in the first cell beneath the header (Figure 33).

NOTE

The letter code (orange) must correspond with the new corresponding activity label. The locator reference (green) must correspond with the individual's associated cell row from the **3_ActivityTimeline** entry tab.

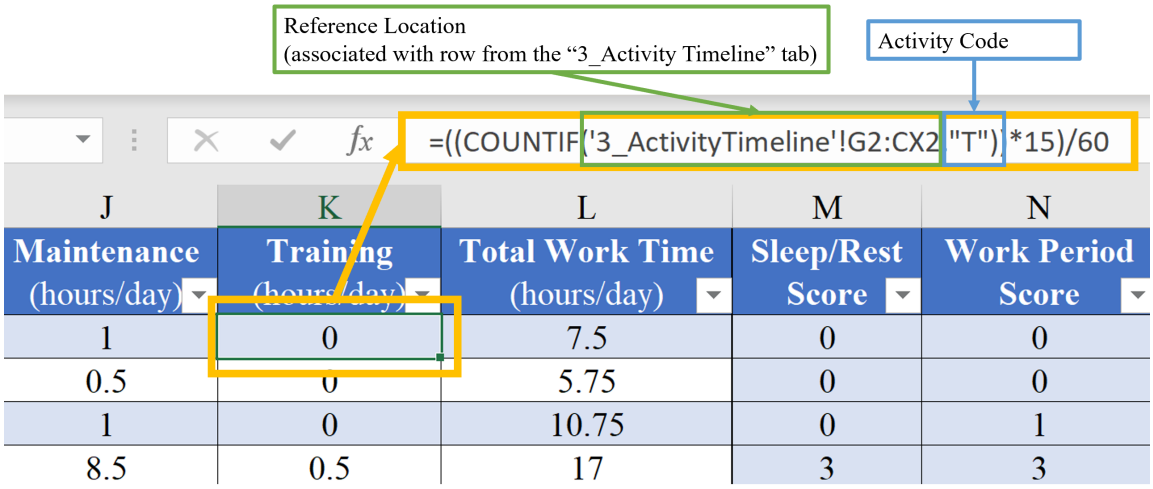


Figure 33. Insert Summary Formula in the **4_ActivitySummary** tab

The following cells in the column should auto-populate with the correct location references within the formula. The summarized activity data is now available for analysis. Adding additional human performance risk scores is not recommended since they have not been evaluated for relevance or accuracy.

C. ADJUST ACTIVITY OR RISK LEVEL THRESHOLD VALUES

To adjust the activity time thresholds and associated risk level, perform the following steps:

1. Open the **5_Thresholds** tab and adjust the values in the yellow boxes (Figure 34).

NOTE

Changing threshold limits is not recommended; however, threshold limits may require adjustment based on changes to the levels of acceptable risk.

Changes in the activity time thresholds will be automatically reflected in the 4_ActivitySummary tab and the subsequent dashboard outputs.

Threshold Limits

Activity Thresholds					Risk Assessment Value
Sleep/Rest Period					
		Sleep/Rest Hours	≤	3	3
3	<	Sleep/Rest Hours	≤	5	2
5	<	Sleep/Rest Hours	<	7	1
		Sleep/Rest Hours	≥	7	0
Total Work Period					
		Work Hours	≤	8	0
8	<	Work Hours	≤	12	1
12	<	Work Hours	<	16	2
		Work Hours	≥	16	3
Watch Rotation Type					
		Fixed			0
		Rotating			1
Number of Watch Sections					
		Watch Sections	≤	2	2
		Watch Sections	=	3	1
		Watch Sections	≥	4	0

Risk Level	
Values	**Rating**
8 +	Critical
5 - 7	Serious
2 - 4	Moderate
0 - 1	Minor

Figure 34. Activity Threshold Limits Adjustment in the **5_Thresholds** tab

D. ADD OR ADJUST A PIVOTTABLE

To add a new PivotTable, open the **4_ActivitySummary** tab and follow the steps outlined in the yellow boxes (Figure 35).

1. Go and select **Insert** from the ribbon.
2. Select PivotTable or Recommended PivotTables.
3. Ensure the entire table is selected.
4. Select the location for the new PivotTable.
5. Select **OK**.

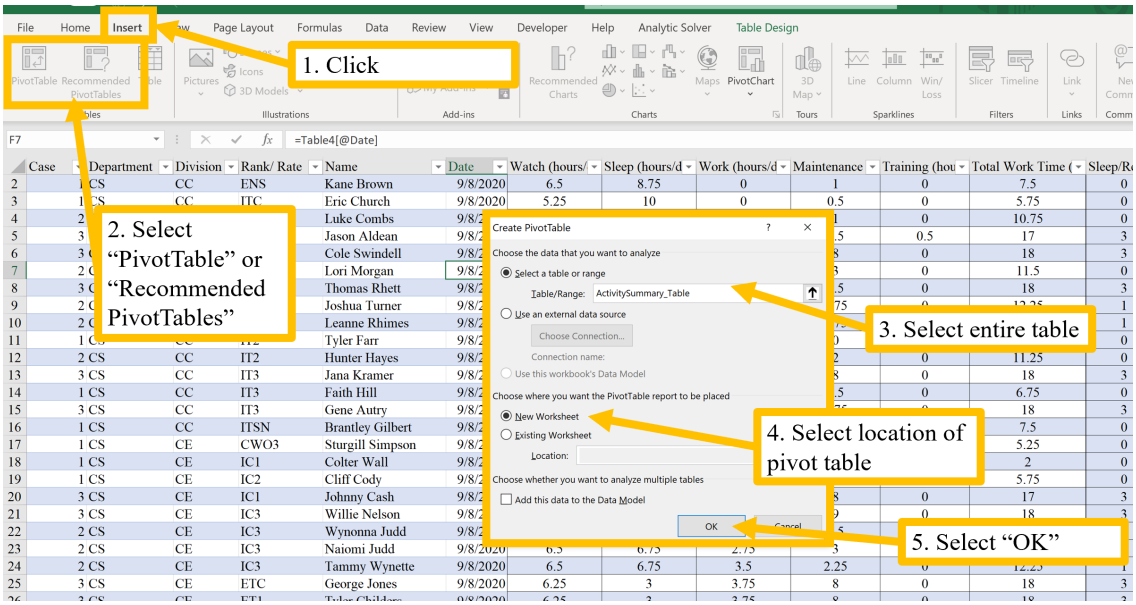


Figure 35. Create a New PivotTable

6. Complete your new PivotTable by dragging the fields to the desired areas (Figure 36)

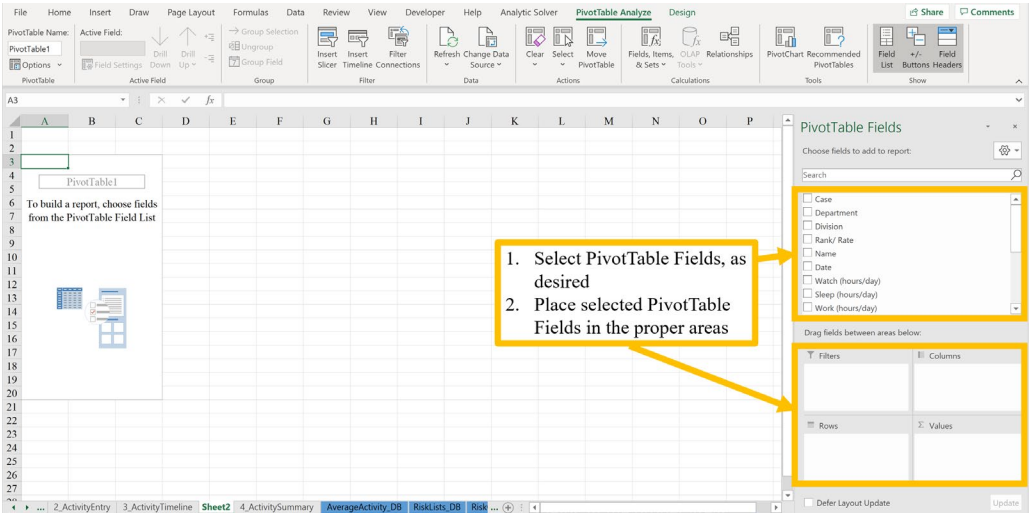


Figure 36. Complete PivotTable

7. Ensure that the new PivotTable is connected to the proper slicers and timelines (Figure 37).

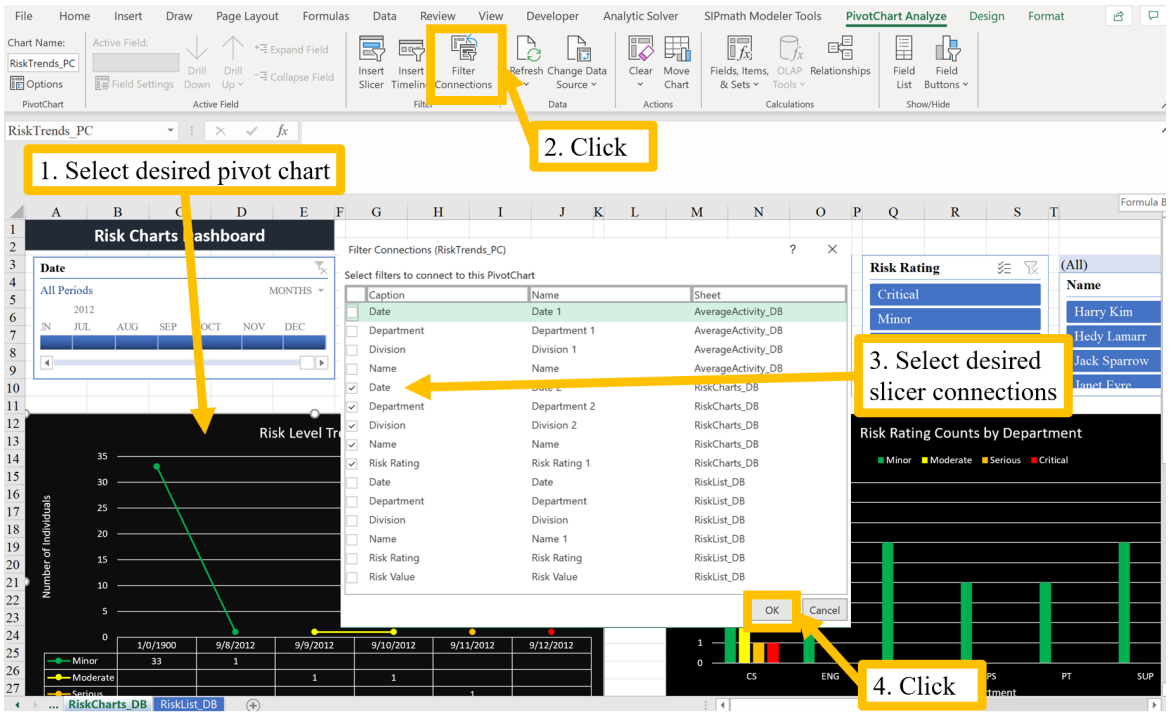


Figure 37. Adjust PivotTable Connections

To adjust an existing PivotTable, follow the steps outlined in the yellow boxes (Figure 38).

1. Right-click along the bottom tabs.
2. Select **Unhide** from the drop-down menu and select the desired tab.
3. Modify the PivotTable, as desired.
4. Ensure the updated or new PivotTable is connected to the proper slicers (Figure 37).

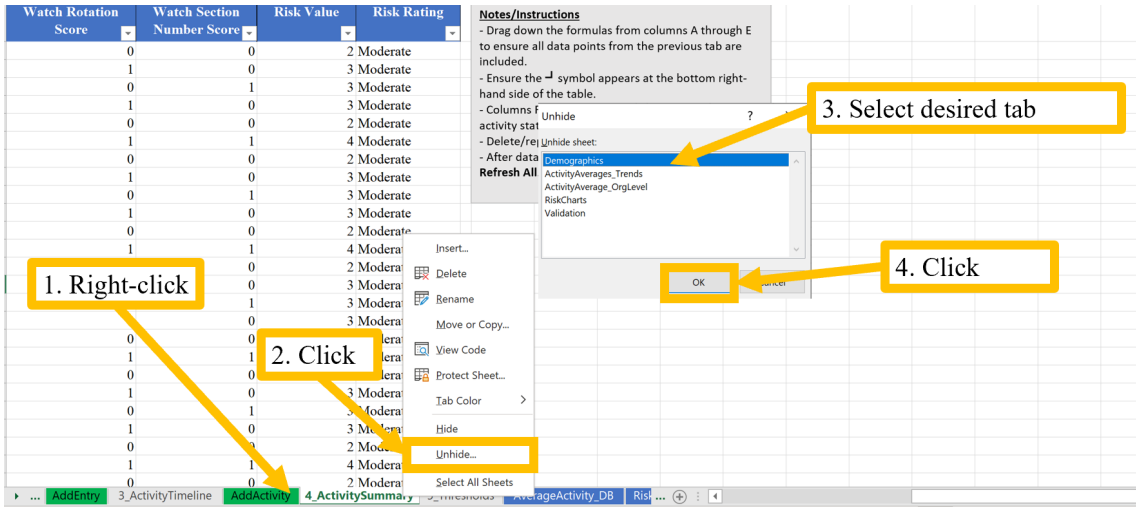


Figure 38. Unhide Developer Tab

E. ADD OR ADJUST A PIVOTCHART

To add a new PivotChart, perform the following steps:

1. Select an existing **PivotTable** and follow the steps outlined in the yellow boxes (Figure 39).
2. Select an area within the PivotTable.
3. Click PivotChart or Recommended PivotChart.
4. Select the desired chart and click **OK**.
5. The chart will appear next to the PivotTable. You may move it to another location by right clicking the PivotChart and selecting **Move**.
6. Select a new location for your PivotChart.

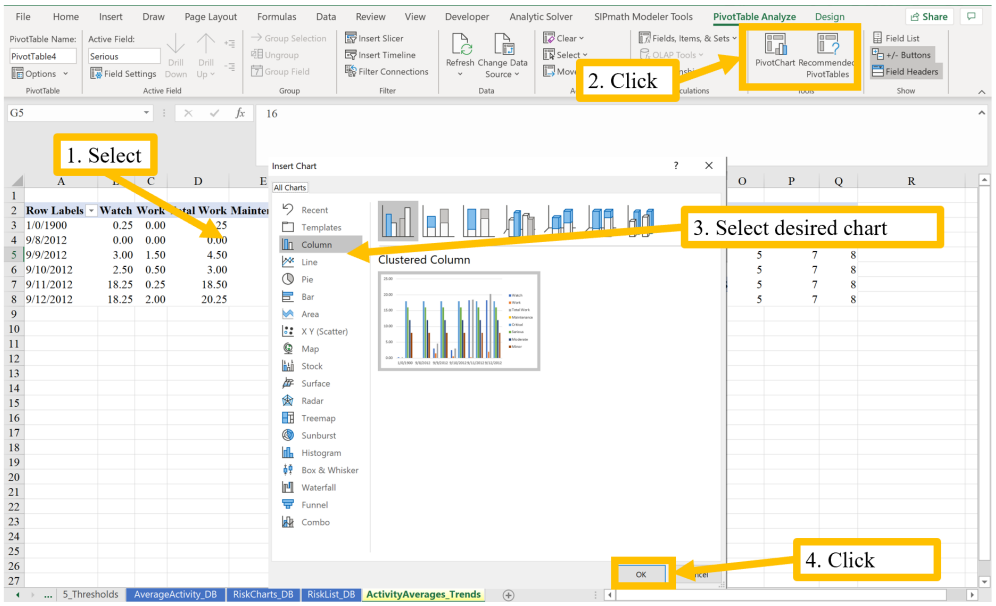


Figure 39. Create a New PivotChart

To adjust an existing PivotChart, perform the following steps:

1. Right-click along the bottom tabs and follow the steps outlined in the yellow boxes (Figure 40).

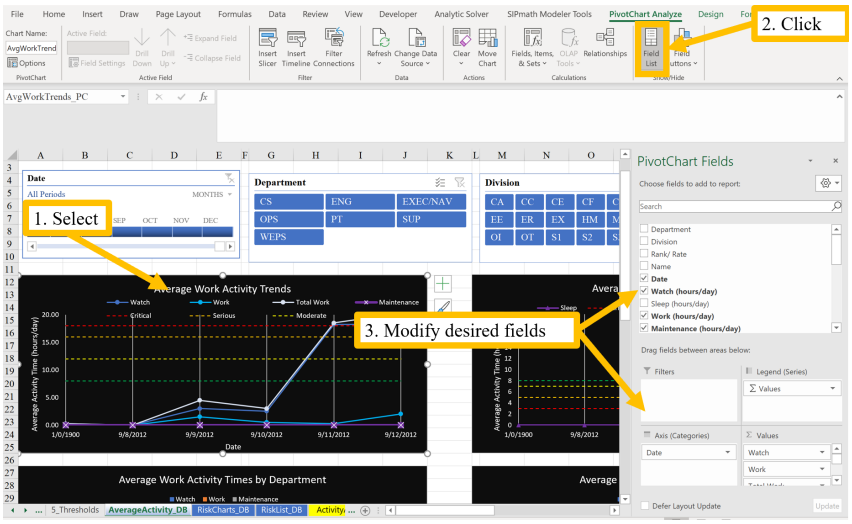


Figure 40. Modify PivotChart

2. Select **Field List** from the ribbon.

3. Modify the PivotChart fields, as desired.

4. Users may also choose from the available chart modifications outlined in Figure 41.

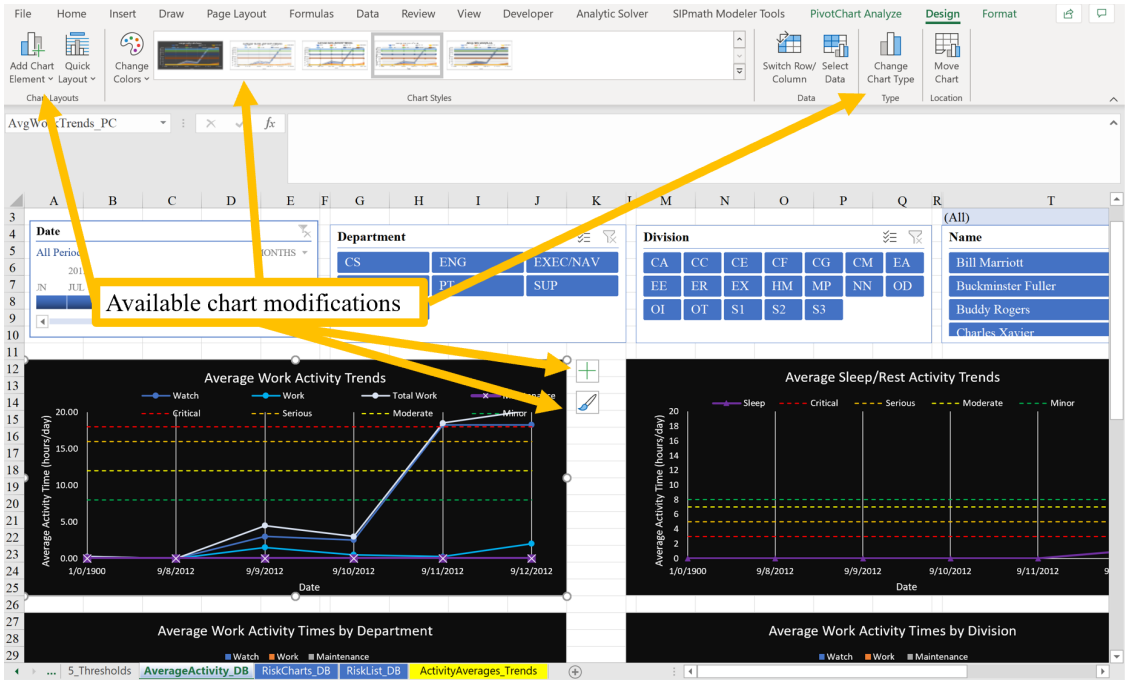


Figure 41. Available Chart Modifications

5. Ensure the updated **PivotChart** is connected to the proper slicers (Figure 37).

F. ADD OR ADJUST A SLICER OR TIMELINE

To add or adjust a slicer or timeline, perform the following steps:

1. Select an existing **PivotChart** and follow the steps outlined in the yellow boxes (Figure 42).

2. Select Insert Slicer or Insert Timeline.

3. Select desired slicers from the pop-up menu.

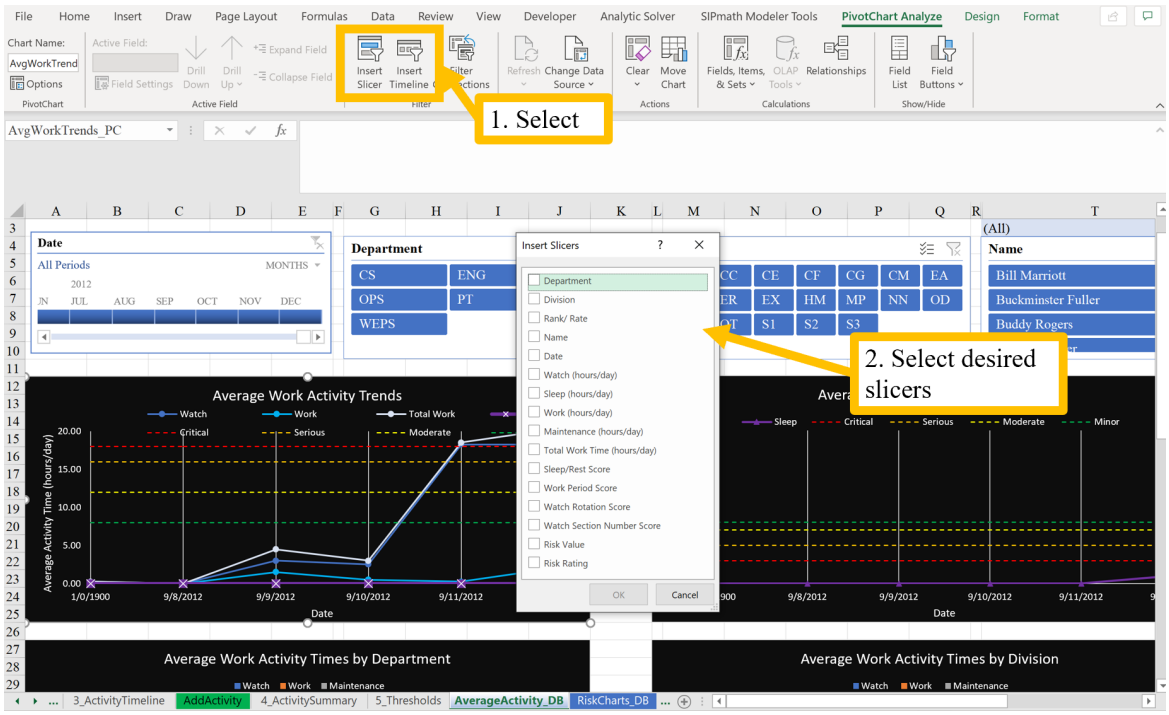


Figure 42. Create New Slicers

4. Modify slicer settings and formatting, as desired (Figure 43).

5. Ensure the updated or new PivotTable is connected to the proper slicers (Figure 37).

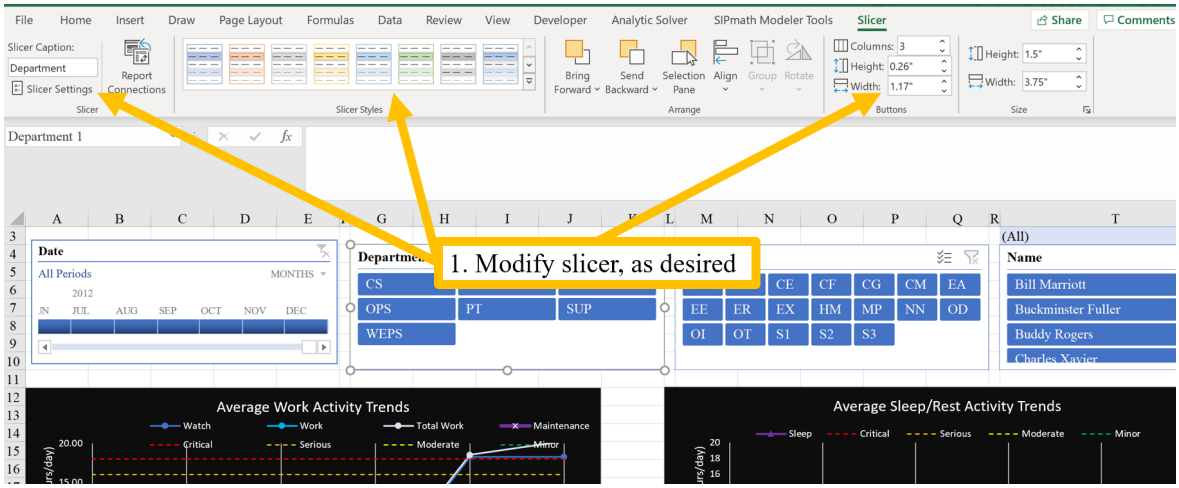


Figure 43. Adjust Slicer Settings

G. VALIDATE CELL INPUTS

To validate cell inputs, perform the following steps:

1. Select the desired cells from the table you wish to validate and follow the steps outlined in the yellow boxes (Figure 44).

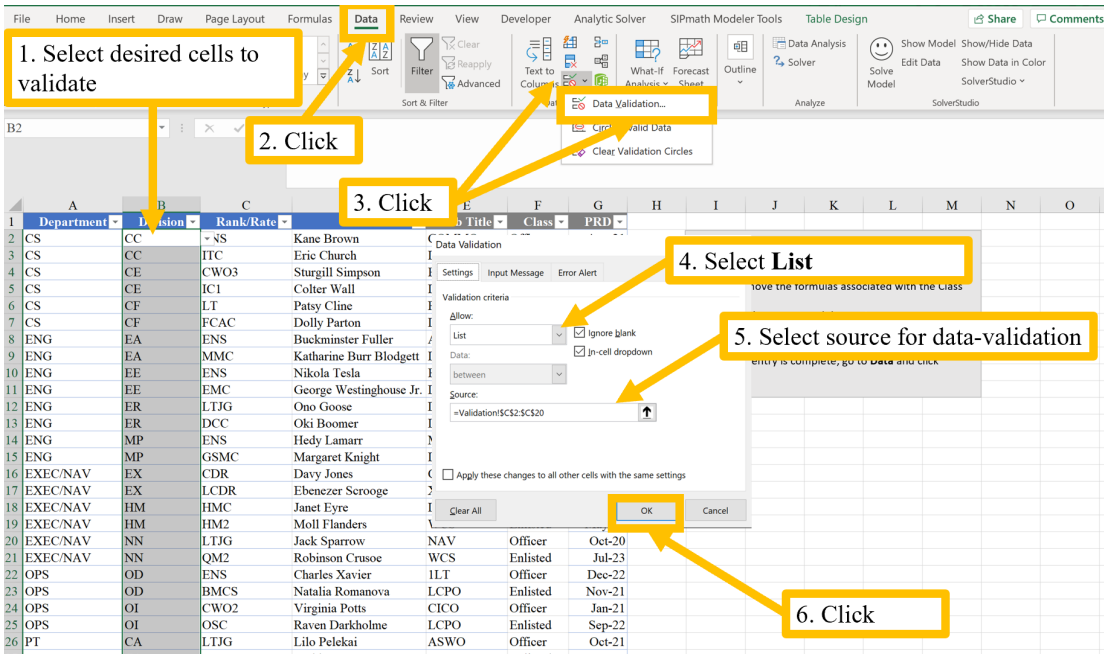


Figure 44. Validate Cells Values

2. Click **Data** from the ribbon.

3. Select Data Validation.

4. Select **List** from the drop-down menu.

5. Enter the source for data-validation values.

> ***NOTE***
>
> The **Validation** tab contains a list of existing data validation values. You may add or modify

6. Select **OK**

VI. INITIAL USE CONFIGURATION QUICK GUIDE

Figure 45 outlines the abbreviated initial use configuration instructions, steps 1 through 11, for the SMART risk assessment tool. More detailed instructions are available in Chapter IV. Additionally, there is a short video tutorial available through the Naval Postgraduate School Dudley Knox Library.

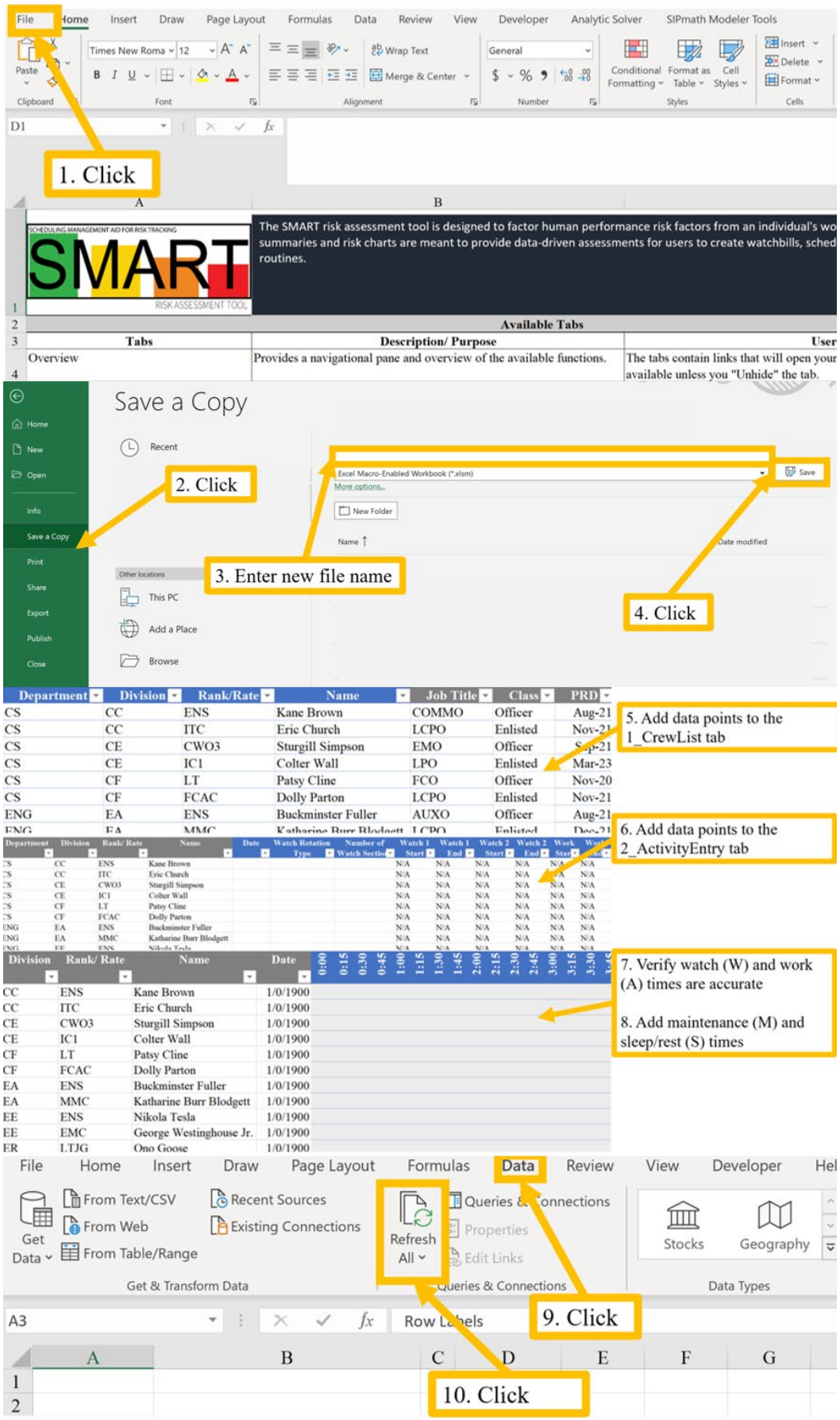

1. Click
2. Click
3. Enter new file name
4. Click
5. Add data points to the 1_CrewList tab
6. Add data points to the 2_ActivityEntry tab
7. Verify watch (W) and work (A) times are accurate
8. Add maintenance (M) and sleep/rest (S) times
9. Click
10. Click
SMART
RISK ASSESSMENT TOOL
The SMART risk assessment tool is designed to factor human performance risk factors from an individual's wo
summaries and risk charts are meant to provide data-driven assessments for users to create watchbills, sched
routines.
Available Tabs
Tabs
Description/ Purpose
Overview
Provides a navigational pane and overview of the available functions.
Save a Copy
Excel Macro-Enabled Workbook (*.xlsm)
Department
Division
Rank/Rate
Name
Job Title
Class
PRD

Figure 45. Quick Initial Use Configuration Guide

VII. LIST OF REFERENCES

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