**Assignment– 3**

**Measuring Workload and Identifying Hazards**

Date: July 16, 2017 Author: Anukul Raj

Mental workload is defined in terms of an interaction between task requirements and human capabilities or resources. It characterizes the demands of the tasks imposed on limited information processing resources. In terms of the task requirements, it can be viewed as an independent, external variable with which the working subjects have to cope more or less efficiently. To estimate the mental workload NASA developed a tool known as NASA Task Load Index or, NASA TLX as it is more commonly known. The NASA TLX consists of six subscales to measure various aspects of MWL, the combination of these categories provide an accurate rating for MWL. The six subscales can broadly be categorized into three categories Task Related, Behavior Related and Subject Related.

The Task Related is used for measurement of the objective demands of the task. It gives the estimate of the physical, mental and temporal constraints involved in doing the task. The physical demands represent the physical components of the task such as, a lot of buttons on the screen were have to be touched simultaneously in the Avion Flight Simulator task etc. The mental demand is an estimator of the mental activity that is required while performing the task such as in the Elephant Memory Task. The temporal demands give a measurement of the time pressure felt in doing an activity such as remembering things in allotted amount in the Elephant Memory Task.

The Behavior related tasks give the estimate of the individual's own evaluation of the task, this is measured through the Performance and Effort. The Performance is an individual’s own estimate about they performed the tasks. The effort gives the estimate of the person’s own opinion of how hard they think they worked in order to complete the task.

The subject overload, estimated the psychological impact of the task on the individual. It is measured by the Frustration that an individual feels while performing the task.

So, even though the workload is something that is experienced by each individual differently for different tasks, NASA TLX gives an accurate rating of the physiological involvement of the person in performing the task and hence, can be used to as an estimator of mental workload.

To measure the mental workload incurred by persons while performing the task, four different tasks were given to four different participants. In each case, the possible parameters such as time and accuracy of the task are noted. The first task is to identify the color of the letter displayed on the screen and the participant accomplished the task with an overall score of 100%. For 34 trials the average time taken to identify the color of the word shown is 1164 ms. As this game involved only identifying the color of the text and then pressing the corresponding button, this task does not have much mental, physical or temporal demands. The overall performance of the participant was good and less effort and frustration has been involved. Hence, the overall mental workload is estimated to be 13.79 as shown in Appendix-A.

The second task, namely elephant memory demands to identify 25 words in the period of 45 seconds divided into various grids of a combination of words. Three trials were conducted and each trial yielded different accuracy value. For this task, given the time constraint to answer there was a lot of temporal demand. Also as there was a lot of remembering involved the participant felt a lot of mental demands of this task was a lot higher. This task involved many mental and temporal demands so, the participant’s own evaluation of performance also inclined on the failure side of the NASA TLX. The rating on the mental workload came out to be 63.33 as shown in Appendix-B.

The third task requirement was to identify the required colored shape in a set of figures for a span of 4 minutes. It is found that the participant performing this task is found to be under more mental demand and had little physical demand. However, the temporal demand is present but it is not found to be very significant as identifying the figure in a set of figures may not have been very laborious. The participant is satisfied with the performance and did not feel a lot of effort, the frustration level is also low as per the evaluation. The overall mental workload rating is estimated and it is found to be on the lower side with a value of 15.80 as shown in Appendix-C.

The requirement for the fourth task was to complete three missions on the Avion Flight Simulator application. In performing this task, the participant seemed highly frustrated unlike other three tasks, as there was a lot of physical coordination required to accomplish the task. The flight takes off and the airport taxying, as per the participant seemed easier and were accomplished in a single go. However, the flying around demanded three trials in order to accomplish. It took a total of 10 minutes long to achieve it with an accuracy of 83.33%. As is evident from the time taken to complete the task and the accuracy, this task involved a lot of frustration for the participant and involved a lot of effort. Hence, the corresponding values in the NASA TLX came to be very high for the frustration, effort and physical demands. Although the task is accomplished by the end of the task, it involved a lot of effort. The overall rating for performance is also on the failure side, and the mental workload rating for this task came out to be 61.87 as shown in Appendix-D.

Comparing the four workload ratings, it is to realize that as the first and third task had very little to offer in terms of the mental, physical or temporal demands so their ratings on NASA TLX is estimated to be on the lower side of the scale with just 13.79 and 15.80 percent. The second and fourth task was a lot demanding and hence their rating is higher on the NASA TLX index with 63.33 and 61.87 percent respectively.

The highest workload is recorded for the elephant memory and the lowest mental workload recorded for the color identification. There seems to be a little mental, physical demand in the color identification task when compared to the elephant memory which demanded higher levels of concentration leading to the higher workload. This is because in the Elephant Memory participant has to remember and then answer whereas, in color task participant had just to look and answer. Also, the first and third task cognitive brain processes the information, it’s more of a reflexive action hence, less mental demands than the second and fourth where the information is processed in the analytical part, information it processed, stored and retrieved and based on that decision has to be made.

**Appendix**

**Appendix-A**

**Task 1: Stroop Test**

**Pairwise Comparison of Stroop Test:**

|  |  |  |  |
| --- | --- | --- | --- |
| Frustration  Or  Effort | Performance  Or  Mental Demand | Effort  Or  Performance | Temporal Demand  Or  Frustration |
| Performance  Or  Temporal Demand | Mental Demand  Or  Effort | Temporal Demand  Or  Effort | Physical Demand  Or  Frustration |
| Mental Demand  Or  Physical Demand | Effort  Or  Physical Demand | Performance  Or  Frustration | Physical Demand  Or  Temporal Demand |
| Frustration  Or  Mental Demand |  | Physical Demand  Or  Performance | Temporal Demand  or  Mental Demand |

**TLX Scale:**

***NASATaskLoad Index***

*Hart and Staveland’s NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales*

|  |  |  |
| --- | --- | --- |
| Name  Nikita Singh | Task  Color | Date  July 14, 2017 |

Mental Demand How mentally demanding was the task?

✓

Very Low Very High

Physical Demand How physically demanding was the task?

✓

Very Low Very High

Temporal Demand How hurried or rushed was the pace of task?

✓

Very Low Very High

Performance How successful were you in accomplishing

what you were asked to?

✓

Perfect Failure

Effort How hard did you have to work to accomplish

your level of performance?

✓

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed,

and annoyed were you?

✓

Very Low Very High

**Weighted Rating Worksheet:**

|  |  |  |  |
| --- | --- | --- | --- |
| WEIGHTED RATING WORKSHEET | | | |
| Scale Title | Weight | Raw Rating | Adjusted Rating  (Weight X Raw) |
| Mental Demand | 5 | 20 | 100 |
| Physical Demand | 0 | 0 | 0 |
| Temporal Demand | 4 | 16 | 64 |
| Performance | 3 | 6 | 18 |
| Effort | 2 | 4 | 8 |
| Frustration | 1 | 4 | 4 |

Sum of “Adjusted Rating” Column = 194

13.79

WEIGHTED RATING =

[i.e.. (Sum of Adjusted Ratings)/15]

**Appendix-B**

**Task 2: Elephant Memory**

**Pairwise Comparison for Elephant Memory**

|  |  |  |  |
| --- | --- | --- | --- |
| Frustration  Or  Effort | Performance  Or  Mental Demand | Effort  Or  Performance | Temporal Demand  Or  Frustration |
| Performance  Or  Temporal Demand | Mental Demand  Or  Effort | Temporal Demand  Or  Effort | Physical Demand  Or  Frustration |
| Mental Demand  Or  Physical Demand | Effort  Or  Physical Demand | Performance  Or  Frustration | Physical Demand  Or  Temporal Demand |
| Frustration  Or  Mental Demand |  | Physical Demand  Or  Performance | Temporal Demand  or  Mental Demand |

**TLX Scale:**

***NASATaskLoad Index***

*Hart and Staveland’s NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales*

|  |  |  |
| --- | --- | --- |
| Name  Sreyasi Sharma | Task  Elephant Memory | Date  July 15, 2017 |

Mental Demand How mentally demanding was the task?

✓

Very Low Very High

Physical Demand How physically demanding was the task?

✓

Very Low Very High

Temporal Demand How hurried or rushed was the pace of task?

✓

Very Low Very High

Performance How successful were you in accomplishing

what you were asked to?

✓

Perfect Failure

Effort How hard did you have to work to accomplish

your level of performance?

✓

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed,

and annoyed were you?

✓

Very Low Very High

**Weighted Rating Worksheet:**

|  |  |  |  |
| --- | --- | --- | --- |
| WEIGHTED RATING WORKSHEET | | | |
| Scale Title | Weight | Raw Rating | Adjusted Rating  (Weight X Raw) |
| Mental Demand | 4 | 76 | 304 |
| Physical Demand | 0 | 0 | 0 |
| Temporal Demand | 5 | 90 | 450 |
| Performance | 3 | 36 | 108 |
| Effort | 2 | 36 | 72 |
| Frustration | 1 | 16 | 16 |

Sum of “Adjusted Rating” Column = 950

63.33

WEIGHTED RATING =

[i.e.. (Sum of Adjusted Ratings)/15]

**Appendix-C**

**Task 3: Visual Task**

**Pairwise Comparison of Visual Task:**

|  |  |  |  |
| --- | --- | --- | --- |
| Frustration  Or  Effort | Performance  Or  Mental Demand | Effort  Or  Performance | Temporal Demand  Or  Frustration |
| Performance  Or  Temporal Demand | Mental Demand  Or  Effort | Temporal Demand  Or  Effort | Physical Demand  Or  Frustration |
| Mental Demand  Or  Physical Demand | Effort  Or  Physical Demand | Performance  Or  Frustration | Physical Demand  Or  Temporal Demand |
| Frustration  Or  Mental Demand |  | Physical Demand  Or  Performance | Temporal Demand  or  Mental Demand |

**TLX Scale:**

***NASATaskLoad Index***

*Hart and Staveland’s NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales*

|  |  |  |
| --- | --- | --- |
| Name  Divya Katiyar | Task  Visual Task | Date  July 15, 2017 |

Mental Demand How mentally demanding was the task?

✓

Very Low Very High

Physical Demand How physically demanding was the task?

✓

Very Low Very High

Temporal Demand How hurried or rushed was the pace of task?

✓

Very Low Very High

Performance How successful were you in accomplishing

what you were asked to?

✓

Perfect Failure

Effort How hard did you have to work to accomplish

your level of performance?

✓

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed,

and annoyed were you?

✓

Very Low Very High

**Weighted Rating Worksheet:**

|  |  |  |  |
| --- | --- | --- | --- |
| WEIGHTED RATING WORKSHEET | | | |
| Scale Title | Weight | Raw Rating | Adjusted Rating  (Weight X Raw) |
| Mental Demand | 3 | 27 | 81 |
| Physical Demand | 0 | 0 | 0 |
| Temporal Demand | 2 | 6 | 12 |
| Performance | 4 | 20 | 80 |
| Effort | 4 | 12 | 48 |
| Frustration | 2 | 8 | 16 |

Sum of “Adjusted Rating” Column = 237

15.80

WEIGHTED RATING =

[i.e.. (Sum of Adjusted Ratings)/15]

**Appendix-D**

**Task 4: Avion Flight Simulator**

**Performance Comparison for Avion Flight Simulator:**

|  |  |  |  |
| --- | --- | --- | --- |
| Frustration  Or  Effort | Performance  Or  Mental Demand | Effort  Or  Performance | Temporal Demand  Or  Frustration |
| Performance  Or  Temporal Demand | Mental Demand  Or  Effort | Temporal Demand  Or  Effort | Physical Demand  Or  Frustration |
| Mental Demand  Or  Physical Demand | Effort  Or  Physical Demand | Performance  Or  Frustration | Physical Demand  Or  Temporal Demand |
| Frustration  Or  Mental Demand |  | Physical Demand  Or  Performance | Temporal Demand  or  Mental Demand |

**TLX Scale:**

***NASATaskLoad Index***

*Hart and Staveland’s NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales*

|  |  |  |
| --- | --- | --- |
| Name  Rishi Sabharwal | Task  Avion Flight Simulator | Date  July, 16 2017 |

Mental Demand How mentally demanding was the task?

✓

Very Low Very High

Physical Demand How physically demanding was the task?

✓

Very Low Very High

Temporal Demand How hurried or rushed was the pace of task?

✓

Very Low Very High

Performance How successful were you in accomplishing

what you were asked to?

✓

Perfect Failure

Effort How hard did you have to work to accomplish

your level of performance?

✓

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed,

and annoyed were you?

✓

Very Low Very High

**Weighted Rating Worksheet:**

|  |  |  |  |
| --- | --- | --- | --- |
| WEIGHTED RATING WORKSHEET | | | |
| Scale Title | Weight | Raw Rating | Adjusted Rating  (Weight X Raw) |
| Mental Demand | 1 | 4 | 4 |
| Physical Demand | 4 | 80 | 320 |
| Temporal Demand | 0 | 0 | 0 |
| Performance | 1 | 12 | 12 |
| Effort | 4 | 72 | 288 |
| Frustration | 4 | 76 | 304 |

Sum of “Adjusted Rating” Column = 928

61.87

WEIGHTED RATING =

[i.e.. (Sum of Adjusted Ratings)/15]