14. MODULE
OCRA Multitask

INTRODUCTION

Scope of application. The module *OCRA Multitask* allows you to analyze repetitive tasks of the upper limbs with clearly defined work cycles by applying the current regulations based on risk assessment using the OCRA index as well as the latest scientific-technological advances in the methodology made by organizations of recognized prestige.

Contents. The technical actions carried out by the worker in order to complete a work cycle must be identified and counted for each of the repetitive subtasks that make up the task. This makes it possible to calculate the *number of actual technical actions (ATA)* performed during the work shift. Force, posture, repetitiveness and other additional risk factors of such technical actions are then determined, which allows you to calculate the *number of reference technical actions (RTA)* for the analyzed conditions. Finally, the *OCRA index* is obtained for each upper limb. Three risk levels are determined according to that index.

Source. This module is based on:

- "Method 2 – Detailed risk assessment" of the EN standard 1005-5 (2007) regarding the assessment of the risk posed by high frequency repetitive handling. This standard is, in turn, based on the OCRA method (*Occupational Repetitive Actions*) originally developed by the EPM research center in Milan [Colombini, Occhipinti y Grieco, 2002].

- The article "Ocra method: a new procedure for analysing multiple repetitive tasks [E. Occhipinti, D. Colombini, 2009] *Research Unit Ergonomics of Posture and Movement (EPM), Foundation Don Gnocchi Onlus Milan –Italy".* Presented in 17th IEA Conference of the International Ergonomics Association August 9 - 14, 2009 Beijing, China.

DATA

The analysis is started by selecting the module *OCRA Multitask* in the *New Task* window (Figure 1).

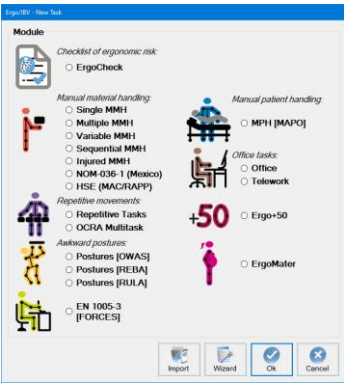This opens the main window of the module (Figure 2), where the information is entered.

Figure 1: Access to module OCRA Multitask

Figure 2: OCRA Multitask – Main window

Identification. The data that identify the case are registered in the header of the main window: name of the task and company, date of analysis and relevant observations.

Repetitive subtasks. The first step is to define the organization of the work, which may include one or more repetitive subtask, by pressing the *Organiz.* button and accessing the corresponding window. The repetitive subtasks that have been defined will be displayed as a table at the top of the main window. The second step is to give detailed information on each repetitive subtask by selecting the corresponding row and pressing the *Data* button in the main window.

The content and how to enter the information in the different windows is described below.

Organization

Pressing the *Organiz.* button in the main window opens the *Organization* window (Figure 3), which includes the following:

- **Repetitive subtasks**. Identify all the repetitive subtasks performed by a worker in a shift or workday. Press the *New* button to enter the name of the subtask (maximum 3 characters) and a brief description of it in the appropriate boxes. The *Delete* button lets you eliminate the selected subtask and all the associated data (previously asking for confirmation). The *Copy* button allows you to create a copy of a subtask with all the data defined in the original subtask (see *Subtask data* in the next section). This can be very useful when there are similar subtasks the data of which are complex to enter. In addition, the button *Import* allows you to reuse subtasks defined in other OCRA tasks.

- **Distribution of the working hours**. Specify the exact frequency of the events during the working hours (and their duration in minutes), by selecting the relevant options from the drop-down menu:

  o Subtask. The names of all the repetitive subtasks previously defined are shown in order to select the applicable one.
  o Non-repetitive work. It includes non-repetitive work which cannot be regarded as a recovery period of the upper limbs (because it involves physical load); for example, supplying, preparing, cleaning, carrying, etc.
  o Recovery. It includes the pauses and non-repetitive work that can be regarded as recovery of the upper limbs; for example, visual control, etc.

o   Meal. It is the break to have lunch (or dinner in the case of night shifts).

The *New* button creates each row of events, and the *Delete* button eliminates the selected event. The *Up/Down* buttons allow you to change the position of the selected row in the list of events.

Figure 3: OCRA Multitask – Organization

From this information, the program automatically calculates and displays the following data at the bottom of this window:

- **Total time of repetitive work**. It is calculated by adding together the duration (minutes) of all the repetitive subtasks of the working day.
- **Du$_M$ – Duration multiplier**. It depends on the previous data and is obtained with a table of values.
- **Number of hours without adequate recovery**. The hours without a period of "*adequate recovery*" are determined, "adequate" means that each hour of repetitive task has ≥ 10 consecutive minutes of recovery (breaks or work that is considered as recovery), or when there is a 5:1 ratio between the time of repetitive work and the time of recovery. The

hour prior to the meal, if any, and prior to the end of the working day do not count.

- **Rc$_M$ – Recovery multiplier**. It depends on the previous data and is determined with a table of values.

Subtask data

The *Subtask data* window (Figure 4) is accessed by selecting the row of the repetitive subtask and clicking the *Data* button in the main window (Figure 2), which is headed by the name of the subtask, its description and the following variables:

- **D - Duration**. Subtask duration (in minutes) automatically calculated from the events defined in the organization.

- **Cycle time**. Enter the duration (in seconds) of a work cycle that is representative of the subtask.

Technical action	Side	No.	Time (sec)	%cycle	Observations - action
Pull	Right	1,00	1,20	4,00	
Catch (palmar)	Right	4,00	4,80	16,00	
Turn	Right	4,00	6,00	20,00	
Push	Right	4,00	6,00	20,00	
Catch (calliper)	Right	4,00	6,00	20,00	
Place	Right	4,00	6,00	20,00	
Catch (calliper, with force)	Left	4,00	6,00	20,00	
Place (with force)	Left	4,00	6,00	20,00	

	RIGHT	LEFT
Number of technical actions in the cycle	21,0	8,0
F - Frequency (technical actions / min)	42,00	16,00
ATA - Number of actual technical actions, subtask [F x D]	8.400	3.200

Figure 4: OCRA Multitask – Subtask data – Technical actions

The next step is to analyze the contents of the work cycle, identifying and counting its technical actions, and connecting them to different risk factors. This information is entered in the different tabs of this window, as detailed below.

Technical actions

The technical actions performed by the worker must be identified in a **work cycle** representative of the repetitive subtask, taking into account the following concepts:

> *Work cycle*: sequence of the technical actions that are always repeated in the same way.
>
> *Technical actions*: elementary manual actions involving musculoskeletal activity of the upper limbs and which are necessary to complete the operations within the work cycle, such as reaching, grabbing, holding, turning, pushing, cutting, placing, etc.

The following data are recorded for each technical action (Figure 4):

- **Technical action**. Assign a name to the technical action.

- **Side**. Specify the upper limb with which the technical action is performed by selecting right, left or both from the drop-down menu.

- **Number**. Count the number of times that the technical action is repeated in the cycle (identical technical actions must be counted each time they are repeated).

- **Time**. Specify the duration (in seconds) of the technical action in the work cycle, grouping the total number of times that such action occurs in the cycle and accumulating time.

- **% cycle**. It is the proportional duration of the technical action (expressed as a percentage of the cycle time), which is automatically calculated from the previous variable.

- **Observations - action**. Specify the relevant comments or clarifications on that technical action.

Press the *New* button to create each row of technical actions, and the *Delete* button to eliminate the selected row. The *Up* and *Down* buttons allow you to sort the technical actions.

Based on the previous data, the program calculates and displays the following data for each upper limb:

- **Number of technical actions in 1 cycle**. Sum of all the technical actions in the work cycle being analyzed.

- **F - Frequency**. Frequency of the technical actions of the subtask (expressed as the number of technical actions per minute). It is obtained from the previous value and the cycle time.

- **ATA – Number of actual technical actions, subtask**. The number of technical actions carried out in this subtask. It is obtained by multiplying the frequency by the duration of the subtask [F x D].

Force

Specify the force exerted with each upper limb, both right and left, by entering the data in the appropriate tab (Figure 5). For each technical action (whose name and proportional duration within the cycle are automatically displayed) select from the drop-down menu the **force level**, expressed according to the score in the **Borg scale** of perceived exertion (or its equivalent as a percentage of the *maximum voluntary contraction*, MVC):

0	none at all	(0% of the MVC)
0,5	extremely weak	(5% of the MVC)
1	very weak	(10% of the MVC)
2	weak	(20% of the MVC)
3	moderate	(30% of the MVC)
4	quite hard	(40% of the MVC)
≥ 5	hard/very hard	(≥ 50% of the MVC)

Figure 5: OCRA Multitask – Subtask data – Force

The reasons why the force is applied in each technical action can be included in the "'*Observation – action'*" field already mentioned (Figure 4, *Technical actions* tab).

From these data, the software calculates and shows the following for each upper limb:

- **Weighted average force**. It is the average level of force based on time. For all the technical actions of the cycle, the intensity of the force is weighted in proportion to its duration (% cycle).

- **Fo$_M$ – Force multiplier**. If a technical action shows "peaks" of force ≥ 5 in the Borg scale during ≥ 10% of the cycle, this multiplier takes the minimum value (Fo$_M$ = 0.01). If not, its value is obtained with a table, depending on the weighted average force.

Posture

Specify the **postures and movements** of each upper limb, both right and left, by entering the data in the corresponding tab (Figure 6).

Figure 6: OCRA Multitask – Subtask data – Posture (shoulder)

For each technical action (whose name and proportional duration within the cycle are automatically displayed), the different parts of the upper limb (shoulder, elbow, wrist and hand) must be analyzed as follows:

- **Shoulder** (Figure 6). Check the applicable box if the following shoulder postures occur:

    - Flexion ≥ 80°
    - Extension ≥ 20°
    - Abduction ≥ 45°

- **Elbow** (Figure 7). Check the applicable box if the following elbow postures occur:

    - Flexion or extension ≥ 60°
    - Pronation ≥ 60°
    - Supination ≥ 60°

- **Wrist** (Figure 8). Check the applicable box if the following wrist postures occur:

    - Flexion or extension ≥ 45°
    - Radial or ulnar deviation ≥ 20°

- **Hand** (Figure 9). Check the applicable box if the following hand postures occur:

    - Pinch
    - Hook grip
    - Palmar grip (wide grip span, palm open)
    - Power grip (short grip span ≤ 2 cm, power grip)

From these data, the software calculates and shows the following for each upper limb (Figure 6):

- **Po_M – Posture multiplier**. It is obtained using a table of values that depends on the proportional duration (% cycle) of the encoded movements and postures. The Po_M value is shown below those obtained for the different parts of the upper limb. In order to facilitate the redesign, the initials of the body part responsible for this value are identified between brackets (**H**: shoulder, **C**: elbow, **Mñ**: wrist and **Mn**: hand).
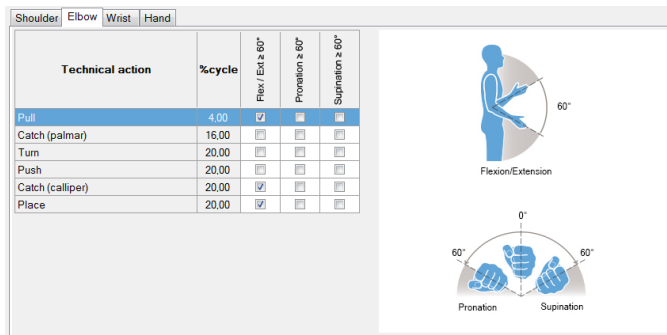
Figure 7: OCRA Multitask – Subtask data – Posture (elbow)
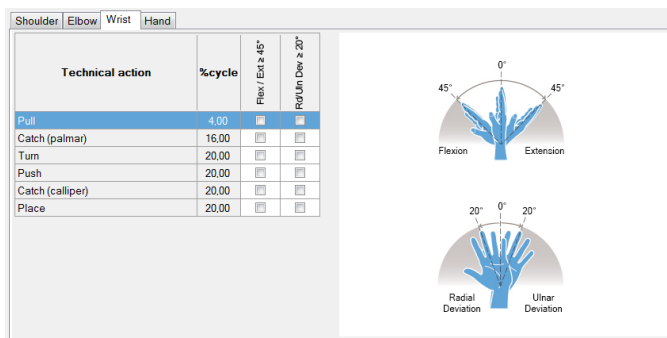
Figure 8: OCRA Multitask – Subtask data– Posture (wrist)
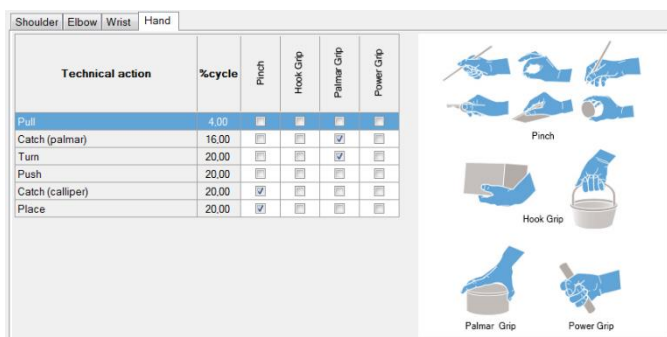
Figure 9: OCRA Multitask – Subtask data – Posture (hand)

Repetitiveness

For each upper limb, both right and left, check the box only if **repetitive movements** are observed **during ≥ 50% of the cycle time** (Figure 10). It refers to the performance of technical actions, or groups of technical actions (sequences) that are identical to each other, during half of the cycle or more. In order to help the evaluator, the name and the proportional duration of the technical actions of the relevant side are shown.

Figure 10: OCRA Multitask – Subtask data – Repetitiveness

The following data is automatically calculated from both this information and the cycle time and it is displayed for each side at the bottom of this window:

- **Re$_M$ – Repetitiveness multiplier**. If the box has been checked or if the cycle time is < 15 seconds, Re$_M$ = 0.7; if not, Re$_M$ = 1.

Additional factors

Finally, specify for each upper limb (both right and left) if certain **additional factors** are present by checking the applicable box (Figure 11); this refers to other risk factors (non-exhaustive list) for which there is evidence of causal relationship or worsening of work-related musculoskeletal disorders in the upper limbs.

Figure 11: OCRA Multitask – Subtask data – Additional

For each technical action (whose name and proportional duration within the cycle are automatically shown), one or more of the following additional factors can be checked:

> o **Vibrations** (use of tools that involve hand/arm vibration).
>
> o **Countershock** (gestures implying blowing or impact forces, such as hammering).
>
> o **Precision** (operations requiring absolute accuracy).

o   Compression (compression localized on the anatomical structures of the hand or forearm from tools, objects or work areas).

o   Cold (cold exposure).

o   Gloves (use of gloves that interfere with the handling ability, the grip, or the movements).

o   Imposed pace (high working pace completely determined by a machine).

o   Other (the objects handled have a slippery surface, sudden or fast movements, etc.).

Any relevant details regarding these factors can be included for each action in the "*Observations – action"* field, as previously mentioned (Figure 4, *Technical actions* tab).

From this information, the following data is automatically calculated and displayed for each side at the bottom of this window.

- **Ad$_M$ – Additional multiplier**. It is obtained using a table that depends on the proportional duration of the technical action that is simultaneously associated with one or more additional factors.

OCRA index calculation

From the previous information, the following data are shown in the main window (Figure 2) for each upper limb, both right and left:

- **OCRA$_{max}$ – Maximum OCRA index of subtasks**. It is the maximum index of the OCRA indices that were independently calculated for each subtask (*OCRA$_i$*). The OCRA index for each subtask *i* is calculated as:

    OCRA$_i$ = [ATA$_i$ / RTA$_i$]

where:

ATA$_i$ - Number of actual technical actions in subtask *i*. It is obtained by the following equation:

ATA$_i$ = F$_i$ x D$_i$

being:

F$_i$	Frequency (technical actions/min) of subtask i
D$_i$	Duration (minutes) of subtask i

RTA$_i$ – Number of reference technical actions for subtask i. It is obtained by the following equation:

$$RTA_i = CF \times D_i \times FoM_i \times PoM_i \times ReM_i \times AdM_i \times DuM_i \times RcM$$

being:

CF	Constant of frequency = 30
D$_i$	Duration (minutes) of subtask i
FoM$_i$, PoM$_i$, ReM$_i$, AdM$_i$	Force, posture, repetitiveness and additional multipliers for subtask i
DuM$_i$	Duration multiplier for subtask i
RcM	Multiplicador de recuperación

- **INC – Increase associated with the rest of subtasks**. It is the increase in the index associated with the rest of the subtasks and is calculated as follows:

  INC = ΔOCRA$_1$ x K

  where:

1,2,…,N	Repetitive subtasks ordered by OCRA index values (1 = highest; N = lowest) computed considering respective real duration multipliers (DuM$_i$) and RcM (the same for all the tasks.
DuM$_i$	Duration multiplier for subtask i real duration.
DuM	Duration multiplier for total duration for all repetitive subtasks.
ΔOCRA$_1$	OCRA of subtask 1 considering DuM, minus OCRA of subtask 1 considering DuM$_1$

  $$K = \frac{(OCRA_{1max} \times FT_1) + (OCRA_{2max} \times FT_2) + \dots + (OCRA_{Nmax} \times FT_N)}{OCRA_{1max}}$$

OCRA$_{imax}$	OCRA of subtask i considering DuM
FT$_i$	Fraction of time (values from 0 to 1) of subtask i with respect to the total repetitive time.

- **OCRA index**. It is a representative value of the risk level of musculoskeletal disorders in the upper limb.

  The OCRA multitask index is calculated as the sum of the two previous variables:

  OCRA Multitask = OCRA$_{max}$ + INC

The risk grows as the index increases, with three levels and their associated color codes, which are interpreted as follows:

≤ 2,2   *No risk* (green). Acceptable condition.

2,3 – 3,5   *Very low risk* (yellow). Improvements are recommended.

> 3,5   *Risk* (red). Not acceptable. It is necessary to redesign the subtask and/or the workstation.

In addition to these results, other values are displayed in the main window (Figure 2). Each row of a repetitive subtask includes the name, duration, the multipliers (force, posture, repetitiveness and additional) and OCRA index obtained for each side. The constant of frequency (which always takes the value 30) and the calculated total duration (DuM$_{tot}$) and recovery (RcM) multipliers are shown below.

REPORT

Pressing the *Report* button in the main window of this module (Figure 2) opens a document that includes the following sections:

- **Identification**. It includes the general data that identify the case (date, task, company, observations) and an image of the task (if a photograph was added).

- **Variables and calculations** (Figure 12). It summarizes in tabular form the most relevant data of the assessment of each upper limb. The information about each subtask is sorted by columns.

- **Task risk** (Figure 12). It offers the OCRA index for each side with the corresponding color code and its interpretation.

- **Organization** (Figure 13). It shows the details of the organization of the work, including the definition of repetitive subtasks, distribution of the working hours, and data related to the duration and recovery multipliers.

- **Subtask data**. Finally, for each subtask analyzed all the data recorded are detailed. The first part of this section shows the technical actions and the data leading to calculation of the ATA for that subtask (Figure 14). The second part includes the data related to the calculation of the RTA (Figure 15).

VARIABLES and CALCULATIONS

	RIGHT			LEFT	
Subtask	A	B		A	B
D - Duration (min)	200	260		200	260
Cycle time (sec)	30,0	60,0		30,0	60,0
Number of technical actions in the cycle	21,0	32,0		8,0	16,0
F - Frequency (technical actions/min)	42,00	32,00		16,00	16,00
ATA - Number of actual technical actions, subtask	8.400	8.320		3.200	4.160
ATA - Number of actual technical actions, total	16.720			7.360	
CF - Constant of frequency	30	30		30	30
FoM - Force multiplier	1,00	1,00		1,00	1,00
PoM - Posture multiplier	0,60	1,00		0,70	1,00
ReM - Repetitiveness multiplier	0,70	1,00		1,00	1,00
AdM - Additional factors multiplier	1,00	1,00		1,00	1,00
DuM - Duration multiplier	1,50	1,00		1,50	1,00
RcM - Recovery multiplier	0,60	0,60		0,60	0,60
RTA - Reference number of technical actions, subtask	2.268	4.680		3.780	4.680
OCRA - Subtask OCRA index [ATA/RTA]	3,70	1,78		0,85	0,89
INC - Increase associated with the rest of subtasks	1,14			0,00	

TASK RISK

	RIGHT		LEFT	
OCRA index [OCRAmax + INC]	4,84	**Risk**	0,89	**No risk**

	Interpretation of OCRA index		Assessment performed by:
≤ 2,2	No risk	Acceptable condition.	
2,3 - 3,5	Very low risk	It is advisable to implement improvements.	
> 3,5	Risk	Not acceptable. The task and/or the workstation must be redesigned.	

Figure 12: OCRA Multitask – Report (variables, calculations and risk)

ORGANIZATION

Repetitive subtasks

Subtask	D Duration (min)	Description
A	200	Drive machinery at the workstation 1
B	260	Drive machinery at the workstation 2

Distribution of the working hours

Event	Minutes
Subtask A	100
Recovery	10
Subtask A	100
Meal	60
Subtask B	130
Recovery	10
Subtask B	130

Total time devoted to repetitive tasks (min)	460	DuMtot - Total duration multiplier	1,00
Total time devoted to non-repetitive tasks (min)	0		
Total recovery time (min)	20		
Shift duration (min)	480		
No. of hours without adequate recovery	4	RcM - Recovery multiplier	0,60

Figure 13: OCRA Multitask – Report (organization)

SUBTASK DATA

Subtask: **A** Description: Drive machinery at the workstation 1
D - Duration (min): **200**
Cycle time (sec): **30,0**

Technical actions

Technical action	Side	No.	Time (sec)	% cycle	Observations - action
Pull	Right	1,0	1,2	4,0	
Catch (palmar)	Right	4,0	4,8	16,0	
Turn	Right	4,0	6,0	20,0	
Push	Right	4,0	6,0	20,0	
Catch (calliper)	Right	4,0	6,0	20,0	
Place	Right	4,0	6,0	20,0	
Catch (calliper, with force)	Left	4,0	6,0	20,0	
Place (with force)	Left	4,0	6,0	20,0	

	RIGHT	LEFT
Number of technical actions in the cycle	21,0	8,0
F - Frequency (technical actions/min)	42,00	16,00
ATA - Number of actual technical actions, Subtask [F x D]	8.400	3.200

Figure 14: OCRA Multitask – Report (subtask data)

Technical action	% cycle	Force (Borg)						Posture													Additional							
		0,5 very, very weak	1 very weak	2 weak	3 moderate	4 somewhat strong	≥5 strong/very strong	Shoulder Flexion ≥ 80°	Extension ≥ 20°	Abduction ≥ 45°	Elbow Flex / Ext ≥ 60°	Pronation ≥ 60°	Supination ≥ 60°	Wrist Flex/Ext ≥ 45°	Rad/Uln Dev ≥ 20°	Hand Pinch	Hook grip	Palmar grip	Power grip	Vibration	Counter shock	Precision	Compression	Cold	Gloves	Imposed pace	Other
RIGHT																											
Pull	4.00	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catch (palmar)	16.00	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Turn	20.00	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Push	20.00	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Catch (calliper)	20.00	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Place	20.00	-	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-

Weig.aver.F.= 0.36 FoM = 1.00 (H) PoM = 0.60 AdM = 1.00

Repetitiveness: Repetitive movements ≥ 50% cycle: Yes ReM = 0.70

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Catch (calliper, with force)	20.00	X	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Place (with force)	20.00	X	-	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-

Weig.aver.F.= 0.20 FoM = 1.00 (H) PoM = 0.70 AdM = 1.00

Repetitiveness: Repetitive movements ≥ 50% cycle: No ReM = 1.00

RTA - Number of reference technical actions, subtask

	CF	D	FoM	PoM	ReM	AdM	DuM	RcM	RTA
RIGHT	30	200	1.00	0.60	0.70	1.00	1.00	0.60	2.268
LEFT	30	200	1.00	0.70	1.00	1.00	1.00	0.60	3.780

Figure 15: OCRA Multitask – Report (subtask data, cont.)