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Xsens MVN RULA Report: The use of inertial motion capture for Cloud based reporting of RULA parameters

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Contents

Xsens MVN RULA report: The use of inertial motion capture for Cloud-based reporting of Rapid Upper Limb Assessments

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Abstract

The newly released Xsens MVN cloud-based Rapid Upper-Limb Assessment (RULA) report is a new tool to assist the Human Factors and Ergonomics community. The cloud-based system allows users to collect lab quality motion capture data in any environment, while having access to reports in a secure manner. This paper describes the RULA report and gives a brief description of the Xsens motion capture system and MotionCloud report. It also presents a worked example using data from a real-life user-case. Collectively, the Xsens MVN RULA report is a revolutionary step for the industry, giving enormous value and potential to help companies undertake their work in an optimal way, while mitigating the risks of developing work-related musculoskeletal disorders.

Introduction

Work-related musculoskeletal disorders (WMSDs) are an area of growing concern across many countries, impacting people's quality of life, and bringing substantial costs to the economy. A WMSD may include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves and supporting blood vessels[1]; with the lower back, neck, shoulder, forearm and hand being the body regions most commonly injured in the workplace[1]. WMSDs are the most common cause of work-related illness or disability than any other group of diseases across the United States, Canada, Finland, Sweden and England[1–4]. As a consequence of this, there are significant costs to the economy, WMSDs costed the US 215 billion dollars in 1995; Canada 26 billion Canadian dollars in 1998; and Germany 38 billion Euros in 2002[5]. This demonstrates a clear requirement for industries to effectively target the factors which contribute to the mechanisms of developing WMSDs. These injuries can often be complex in nature requiring a systematic approach to mitigate the risks of experiencing them.

Several factors have been associated with WMSDs, including repetitive motion, excessive force, awkward or sustained postures, as well as prolonged sitting and standing[5]. For example, in the aged care sector, care workers are exposed frequently to tasks involving manual handling of people, often in confined and/or cluttered spaces in the resident's bedroom or bathroom[6]. As a consequence of these environments, hazards may include awkward posture, leading to high loads placed on the body's tissues. The physical factors the handler is exposed to can include pushing, pulling, lifting and moving of the patient during tasks including transferring patients to and from furniture, repositioning in bed and assisting in daily hygiene[6,7]. Within Australia, workers from the health and social assistance sector, submit more workers compensation claims than any other sector[8]. Of even greater concern, is that this may only represent a fraction of the total disease burden, a study in the United States found that less than 10% of nursing home workers with prevalent lower back pain followed through and submitted a claim[9]. There may also be organisational factors which contribute to the injury mechanism, these can include long working hours, stressful working conditions, workplace culture and increased patient loads[6,10]. Finally, psychosocial aspects of the environment may influence stress processes, perceptions, emotions and behaviours[11].

Occupational Biomechanics, or Ergonomics, aims to optimise design, products or work processes by analysing the way people interact with their environment. To achieve this, one must understand the postures and movements undertaken by the worker, as well as how they interact with tools and/or workstation setup. The goal of this should be to reduce human error, improve productivity, as well as improve safety and comfort to the worker. The Rapid Upper Limb Assessment (RULA) is a subjective observation method of analysing posture which focuses on the upper body, while including some lower body analysis. The RULA uses a series of illustrations of different body postures, with a numerical score allocated to the most common observed posture[12]. RULA was initially developed as a tool to screen adults on their exposure to risk factors for sustaining work-related upper limb disorders[12,13]. Importantly it has been shown to be reliable, with the ability to be performed quickly[12,13]. This has the potential to help companies and their employees undertake work activities such that performance can be improved, whilst reducing the risk of work-related injuries.

RULA provides a systematic process to evaluate all segments of the musculoskeletal system and the working posture at one instance in time. A scoring system is performed to generate an action list, which determines the level of intervention required to mitigate injury risk[14]. This scoring system is needed to determine the level of risk of sustaining injuries caused by static, dynamic, rapidly changing or unstable body postures. Figure 1 shows the final scores and the respective level of intervention needed. As the scores become higher, it indicates a greater risk of experiencing injury and therefore requires a change be implemented.

Scoring: (final score from Table C)
1 or 2 = acceptable posture
3 or 4 = further investigation, change may be needed
5 or 6 = further investigation, change soon
7 = investigate and implement change

Figure 1: Different levels of risk in sustaining WMSDs and change implementation.

However, some limitations may exist with these traditional methods. In its current state, RULA relies on subjective analysis, from either using the naked eye, or 2D video footage viewed from specific anatomical planes (ie. sagittal, frontal, transverse). This may have inherent limitations associated with 2D analysis, including artefact from changing the plane of observation; for example, if a movement is observable along one anatomical plane at a given time, movement of the participant can change the analysis plane, and may show a deceiving joint angle. Further, a naked eye approach is needed to estimate where the joint centre lies if joint angles are being estimated, with baggy clothing potentially influencing where the observer estimates the joint centre. Finally, it only allows the assessor/evaluator to assess an employee’s posture at one point in time and it does not take into account the durations of measured postures, nor the difference between right and left sides.

3D motion capture techniques can greatly improve some of these limitations, providing rich Biomechanical data and an extra depth and reliability to the analysis. 3D motion capture techniques can include opto-electronic and retro-reflective systems, as well as inertial motion capture. While optical systems have a high degree of precision and accuracy and can work well in a laboratory environment, they lack the ecological validity required to understand the workplace.The cost and availability of well-equipped motion capture laboratories with multiple cameras, restricted measurement space in industrial and workplace environments, and occlusion and line of sight problems with the reflective markers[15], make optical systems solutions that are not very viable. Inertial motion capture addresses these shortcomings and allows the measurement of motion outside of motion capture laboratories. Inertial measurement units (IMU) consist of accelerometers, gyroscopes and magnetometers, from which the position and orientation of a body segment can be estimated via the process of sensor fusion[16]. Based on this position and orientation data, joint kinematics can be determined in an ambulatory setting. Traditionally, IMUs suffer from magnetic distortion. However, Xsens IMUs are unique in that they include advanced models based on decades of motion tracking experience to minimize the effect of these distortions. [20] Importantly, IMU’s are relatively inexpensive and portable, making them accessible to a wide variety of settings. Moreover, recent methods have allowed further analysis such as muscle-tendon force, joint moments and joint contact force calculations using exclusively inertial sensor data[17–19].

Recently, Xsens Technologies has dedicated significant efforts to provide the Human Factors and Ergonomics community with an automated RULA tool, allowing them to perform objective analysis across all frames of movement, rather than a single snapshot in time relying on subjective analysis. To this end, a RULA report has been developed with the ability to be both created and stored in a secure cloud-based environment. This has several advantages. File uploads allow the data to be processed without relying on front-end hardware. Additionally, the cloud-based system allows users with assigned permissions to access the reports from any location in a secure manner, improving communication amongst interdisciplinary teams.

The Xsens cloud hosts the new MVN reporting functionality. MVN reporting is a tool that allows the user to create reports generated with Xsens recording files. These reports are used as a tool to help in the analysis and/or interpretation of multiple kinematic parameters in different tasks. These files are uploaded to a secure cloud environment called MotionCloud. The following figure demonstrates the way files are uploaded and visualized for users in a secure manner and how this works in three simple steps from logging in to uploading and report result (Figure 2).

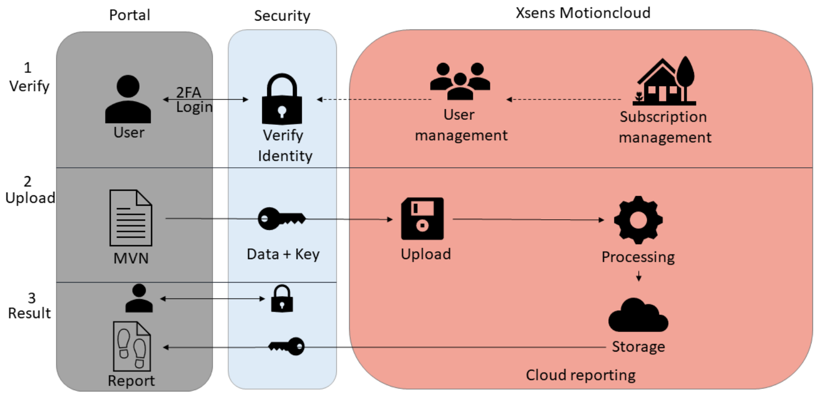
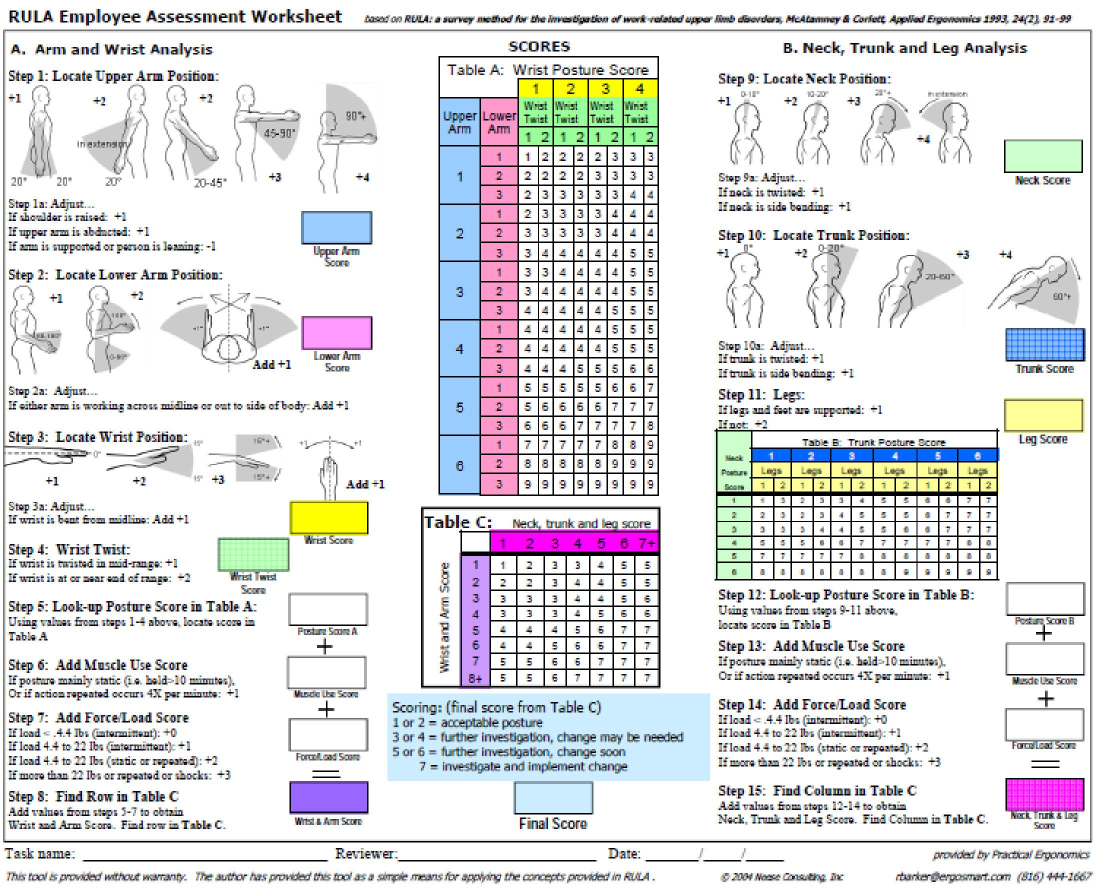


Figure 2: Xsens cloud architecture

The components and methods of RULA shall now be described. A worked example shall be shown with data from a real-life user-case of the RULA.

The Rapid Upper Limb Assessment

The Rapid Upper Limb Assessment uses a systematic process to evaluate the ergonomic risk of postures, load, and muscle use frequency for a given task. RULA considers the biomechanical and postural load requirements on the neck, trunk and upper extremities, and takes into account some lower extremity parameters[12]. Traditionally it has been performed on a single page worksheet with ordered sequential steps to derive the final score (Figure 3)[12].



RULA Employee Assessment Worksheet *based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99*

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:
+1 20° 20° | +2 in extension 20° | +2 20-45° | +3 45-90° | +4 90°+

Step 1a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 2: Locate Lower Arm Position:
+1 | +2 | Add +1

Lower Arm Score

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:
+1 0° | +2 15° 15° | +3 15°+ 15°+ | Add +1

Step 3a: Adjust...
If wrist is bent from midline: Add +1

Wrist Score

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Wrist Twist Score

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A
+

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score
+

Step 7: Add Force/Load Score
If load < 4.4 lbs (intermittent): +0
If load 4.4 to 22 lbs (intermittent): +1
If load 4.4 to 22 lbs (static or repeated): +2
If more than 22 lbs or repeated or shocks: +3

Force/Load Score
=

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain Wrist and Arm Score. Find row in Table C.

Wrist & Arm Score

SCORES

Table A: Wrist Posture Score

Upper Arm	Lower Arm	1 Wrist Twist 1	1 Wrist Twist 2	2 Wrist Twist 1	2 Wrist Twist 2	3 Wrist Twist 1	3 Wrist Twist 2	4 Wrist Twist 1	4 Wrist Twist 2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C: Neck, trunk and leg score

Wrist and Arm Score	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1 or 2 = acceptable posture
3 or 4 = further investigation, change may be needed
5 or 6 = further investigation, change soon
7 = investigate and implement change

Final Score

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position:
+1 0-10° | +2 10-20° | +3 20°+ | +4 in extension

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Neck Score

Step 10: Locate Trunk Position:
+1 0° | +2 0-20° | +3 20-60° | +4 60°+

Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Table B: Trunk Posture Score

Neck Posture Score	1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above, locate score in Table B

Posture Score B
+

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score
+

Step 14: Add Force/Load Score
If load < 4.4 lbs (intermittent): +0
If load 4.4 to 22 lbs (intermittent): +1
If load 4.4 to 22 lbs (static or repeated): +2
If more than 22 lbs or repeated or shocks: +3

Force/Load Score
=

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in Table C.

Neck, Trunk & Leg Score

Task name: ______________ Reviewer: ______________ Date: ___/___/___ *provided by Practical Ergonomics*

This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in RULA. © 2004 Neese Consulting, Inc rbarker@ergosmart.com (816) 444-1667

Figure 3: The RULA assessment worksheet[12]

Arm and Wrist analysis

The upper arm is scored between 1 and 6, with the score based on the amount of shoulder flexion/extension, as well as any adjustment if the shoulder is elevated, abducted or supported in any way. Shoulder flexion is defined as anterior movement of the upper arm in the sagittal plane, while extension is defined as posterior movement. Shoulder abduction is defined as lateral movement of the upper arm away from the body's midline. Shoulder elevation refers to the elevation of the scapula.

The lower arm is scored between 1 and 3, with the score based on the amount of elbow flexion, as well as any adjustment if the lower arm is working away from the body. Elbow flexion is defined as anterior movement of the lower arm with respect to the upper arm in the sagittal plane.

The wrist is scored between 1 and 4, with the score based on the amount of wrist flexion/extension, as well as any adjustment if the wrist is deviated or twisted. Wrist flexion is defined as anterior movement of the hand with respect to the lower arm in the sagittal plane, while extension is defined as posterior movement. Wrist deviation refers to medial or lateral movement of the hand with respect to the lower arm, and are referred to as ulnar and radial deviation respectively. Wrist twist refers to if the wrist is pronated or supinated near its end range of motion. Supination refers to when the surface of the palm is facing upward, while pronation refers to when the surface of the palm is facing downward.

Muscle Use and Force/Load Score

The Muscle Use score box is added if the posture of the given job task is mainly static or held for longer than 10 minutes, or if the repeated action occurs 4 times per minute. If neither of these occur, the muscle use score will be zero. The Fore and Load score is scored between 0 and 3, with the score determined based on the magnitude and frequency of the loads experienced during the given job task.

Neck, Trunk and Leg analysis

The neck position score is scored between 1 and 6, with the score based on the amount of neck flexion/extension, as well as any adjustment if the neck is twisted or bent in any way. Neck flexion is defined as anterior movement of the head in the sagittal plane, or movement of the chin towards the chest, while extension is defined as posterior movement. Neck twist refers to if the head is rotated, whilst bending refers to lateral flexion of the head away from the midline of the body.

The trunk position score is scored between 1 and 6, with the score based on the amount of trunk flexion/extension, as well as any adjustment if the trunk is twisted or bent in any way. Trunk flexion is defined as anterior movement of the trunk in the sagittal plane, or movement of the trunk towards the ground, while extension is defined as posterior movement. Trunk twist refers to if the trunk is rotated, whilst bending refers to lateral flexion of the trunk away from the midline of the body.

The Legs score is scored between 1 and 2, with the score dependant on weight distribution. If the legs are not supported (with an exoskeleton, for example), or if there is uneven weight distribution across right and left sides, the score is 2. If the legs are supported with even weight distribution, the score is 1.

Final Score

The upper arm, lower arm and wrist scores are combined in Table A to determine Posture Score A, this posture score is combined with the muscle use and force load score for the arm and wrist to give the final **Wrist and Arm Score**.

The neck, trunk and leg scores are combined in Table B to determine Posture Score B, this posture score is combined with the muscle use and force load score for the neck trunk and legs to give the final **Neck, Trunk and Leg Score**.

Following this, the Neck, Trunk and Leg Score is combined with the Wrist and Arm Score in Table C, to yield the final score. This final score determines whether further investigation is needed, and whether and changes need to be implemented.

Motion Tracking and Cloud Report

Motion capture is measured using Xsens MVN, which offers two different hardware setup options including a wireless Awinda system as well as a wired Link system. Both systems sample internally at 1000Hz and undergo a strapped-down integration method and data is output at 60Hz maximum (Awinda) and 240Hz maximum (Link) to improve latency[20]. A total of 17 IMU's are mounted on the head, sternum, pelvis, upper legs, lower legs, feet, shoulders, upper arms, forearms and hands for full body motion capture. The data is processed with the matching software Xsens MVN. Prior to performing trials, each participant's segment dimensions must be input into the Xsens MVN software using a tape measure with the subject standing in an upright posture. These measurements consist of the distances of the ankle, knee, hip, shoulder and top of head from the ground. In addition to this the inter-ASIS distance, inter-acromion and inter-dactylion distance is measured representing the pelvis, shoulder and upper arm width respectively, as well as the length of the foot.

The inertial motion capture system is calibrated with the participant holding a neutral pose[16] such as an N-pose or T-pose, immediately followed by a walk calibration. The Xsens MVN estimates the orientation of segments through the combination of individual IMU orientations with a biomechanical model of the human body. Each IMU orientation is achieved through the fusion of accelerometer, gyroscope and magnetometer signals using an extended Kalman filter[16,20]. The neutral pose assumptions from the sensor to segment calibration procedure, relates the 17 sensor orientations to derive the kinematics of 23 body segments[16]. Following this, the participant can undergo their job roles and tasks while the motion capture system records data.

The motion capture data is stored in a secure cloud-based environment. Users can upload motion files via the MotionCloud web browser or via the Xsens MVN software. A RULA can be prepared for each recording with specific frames identified. The report contains a visual demonstration of the data, with the ability to toggle through the timeline of the recording (Figure 4). In addition to this, we see the total RULA score for each respective timeframe of the trial along with a pie chart showing the total percentage of time spent in each level of injury risk.

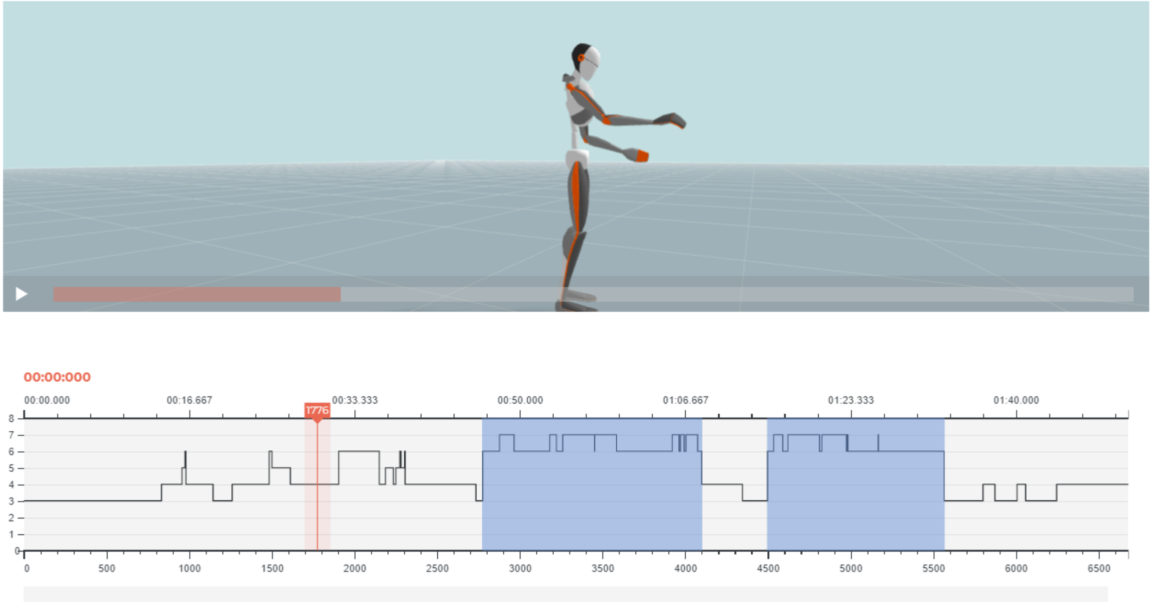


Figure 4: Visual demonstration of the motion capture data.

The user also has the ability to select a given time frame to apply the Muscle Use and Force/Load characteristics for the arms and legs (Figure 5). Once the timeframe is selected, a checkbox exists indicating whether or not the arms or legs were supported, as well as for muscle use, which is added if the posture of the given job task is mainly static or held for longer than 10 minutes, or if the repeated action occurs 4 times per minute. The Force and Load score is selected from the drop-down selection, determined by the magnitude and frequency of the loads experienced during the given job task.

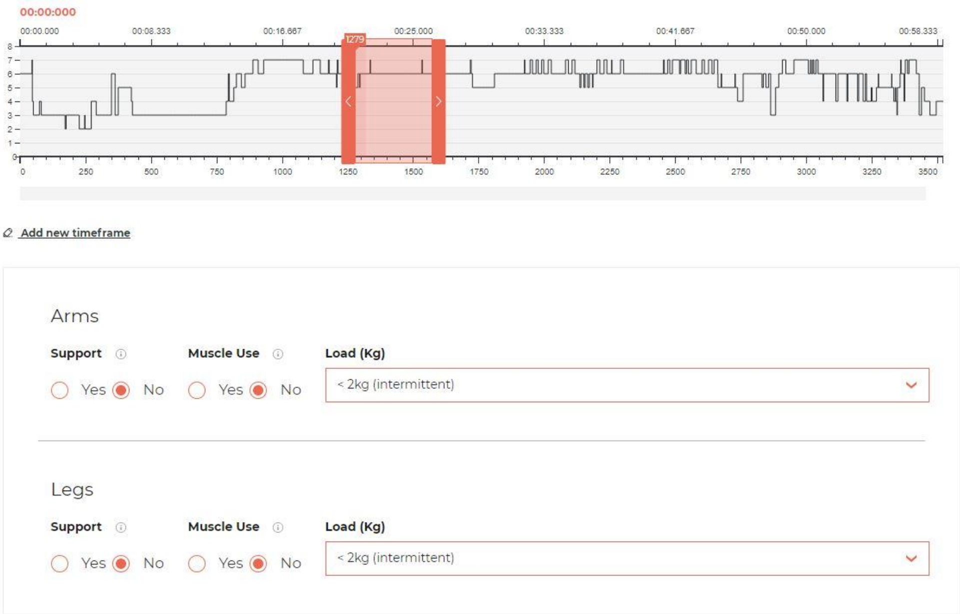


Figure 5: The ability to add timeframes indicating Support, Muscle Use and Load on the Arms and Legs.

At each respective timeframe, the total RULA score is shown, as well as each respective segment score. The upper arm, lower arm and wrist scores are shown highlighted in Table A of the Arm and Wrist Analysis (Figure 6), the value determined in the table is combined with the muscle use and force load score for the arm and wrist, which gives the Wrist and Arm Score.

Table A.		Wrist posture score							
Upper arm	Lower arm	1		2		3		4	
		Wrist twist		Wrist twist		Wrist twist		Wrist twist	
		1	2	1	2	1	2	1	2
1	1	1	2	2	2	2	3	3	3
	2	1	2	2	2	2	3	3	3
	3	2	3	3	3	4	4	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	6	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Figure 6: Table A showing the Upper Arm, Lower Arm and Wrist posture scores.

The neck, trunk and leg scores are shown highlighted in Table B of the Neck, Trunk and Leg Analysis (Figure 7), the value determined in the table is combined with the muscle use and force load score for the neck, trunk and leg, which gives the Neck, Trunk and Leg Score.

Table B.	Trunk posture score											
	1		2		3		4		5		6	
	Legs		Legs		Legs		Legs		Legs		Legs	
Neck posture score	1	2	1	2	1	2	1	2	1	2	1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	7	8	8
5	7	7	7	7	7	8	8	8	8	8	8	8
6	8	8	8	8	8	8	8	9	9	9	9	9

Figure 7: Table B showing the Neck, Trunk and Leg posture scores.

The Wrist and Arm score is combined with the Neck, Trunk and Leg score in Table C (Figure 8), which gives the RULA score for the respective timeframe. It is this value that indicates the level of risk and whether changes be implemented. A score of 1-2 indicates negligible risk and no action needed; a score of 3-4 indicates low risk and that change may be needed; a score of 5-6 indicates medium risk, further investigation and to change soon; while a score of 7 indicates very high risk and to implement change immediately.

Table C.		Neck, trunk and leg score						
		1	2	3	4	5	6	7+
Wrist and arm score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Figure 8: The final RULA score for each respective timeframe.

These Tables show how the different posture scores are broken down, and how they have combined to form the total RULA score for each respective timeframe. The RULA scores can be observed throughout the whole trial, as well as the total percentage of time spent in each level of risk. This is a unique feature of the Xsens MVN RULA report, as it allows a RULA score to be seen throughout the entire duration of the job task, rather than just a single point in time.

Application Example

Many of Xsens' customers have applied the RULA tool across a wide range of activities. The motion capture system is completely portable and available to a wide range of settings, enabling testing and analyses to be done in any environment. The cloud-based reporting tool further allows users with assigned permissions to access the reports from any location in a secure manner, improving communication amongst interdisciplinary teams. The following is a real-life use-case of the Xsens MVN RULA Cloud Reporting Tool in an automotive industry environment.

Diesel fitters and various other mechanic related positions may often find themselves being placed in slouched and stooped over positions for extended periods of time whilst working on an engine. These postures can involve large amounts of twisting and bending while reaching for difficult places in the engine, which may lead to fatigued muscles and injury[21].

To investigate this, a Diesel Fitter was instrumented with an Xsens MVN Awinda system (Figure 9). Motion capture data was collected from 17 sensors placed across the body and sampled at 60 Hz, while the fitter worked on the engine. The data recording was processed and uploaded as an MVNX file to the cloud portal.

Figure 9: A Diesel Fitter instrumented with full-body 17 sensor Xsens MVN Awinda setup. Note that the sensors can be placed under clothing as occlusion is a non-issue with inertial-based motion capture.

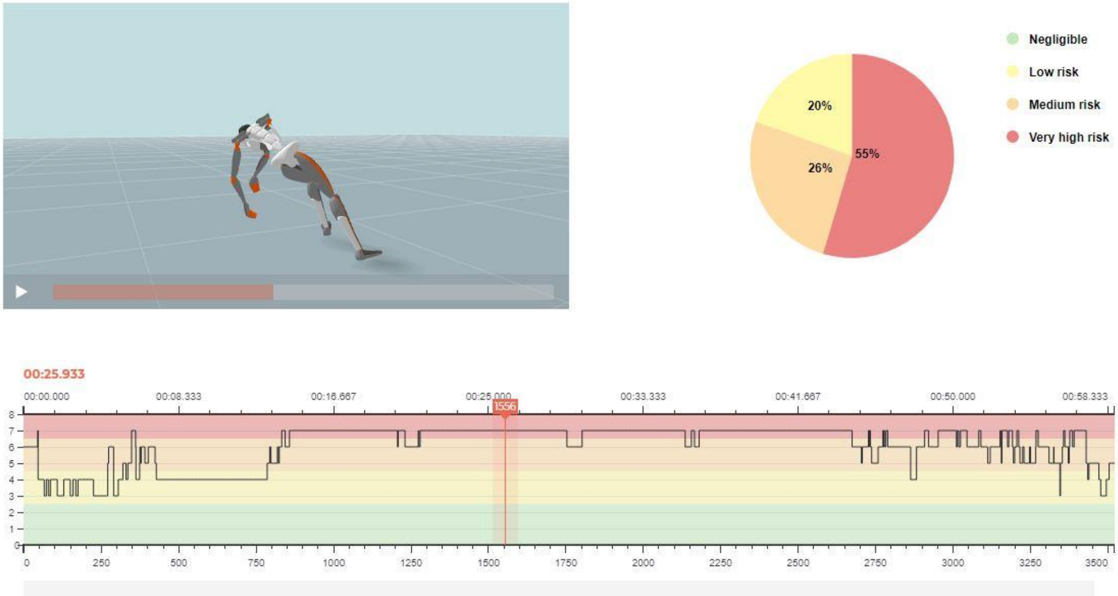


Figure 9: Timeframe where the Diesel Fitter is bending over a tire. The RULA scores for each timeframe and how much time is spent in each risk zone.

The Rapid Upper Limb Assessment showed the following task to contain many high-risk positions, with up to 55% of the time spent in very high risk. This is likely due to the aforementioned slouched and stooped over positions. The data shows large amounts of twisting and bending while reaching for difficult places, this can be observed from the viewport as well. Given that these positions can be held for extended periods of time, it is not surprising why this job can lead to fatigued muscles, and in some cases injury[21].

Given the complex aetiology of many WMSDs, interventions can take on various formats. These can include interventions that pertain to the individual, such as education and appropriate exercises. While they also include task specific and equipment factors, workplace organisation and job design factors[8]. Understanding the physical loads experienced during a task is of paramount importance, as this allows us to influence the design of workstations, tools and the characteristics of the task itself[6,8]. In addition to this, organisational factors that contribute to the injury mechanism can be addressed, these may include long working hours, stressful working conditions, and the overall workplace culture[8,10]. Finally, psychosocial aspects of the workplace environment can be addressed, which may influence stress processes, perceptions, emotions and behaviours[11]. The Xsens MVN RULA Reporting Tool allows WMSDs to be evaluated and analysed in a systematic and efficient way.

Conclusion

In this whitepaper, the newly released Xsens MVN RULA report was presented as a tool to assist the Human Factors and Ergonomics community through automated preparation of upper-limb assessments. The cloud-based system allows users to access the reports in a secure manner, improving the communication amongst interdisciplinary teams. Furthermore, the report enables rich quantitative data throughout the entire trial, rather than a single snapshot in time. The setup is completely wearable and can enable the analysis of workers in their natural environment, thereby facilitating a wider adoption to the community. Collectively, the Xsens MVN RULA report is a revolutionary step for the industry, giving enormous value and potential to help companies undertake their work in an optimal way while mitigating the risks of developing a WMSD.

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