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Ergonomic Evaluation to improve Work Posture

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***Abstract*:-Industries today are facing numerous challenges to maintain the health and performance of employees while attempting to integrate new technologies. The health related problems such as Musculoskeletal Disorders (MSD) and Repetitive Motion Disorders (RMD) are prevalent in workers due to monotonous working on the shop floor. Hence there is a need to document the worker's problems related to their work area and evaluate the results obtained from the survey. Ergonomic assessments confirm that a worker's workstation is ergonomically designed to detract the risk of injury and escalate productivity. Ergonomic assessment tools such as RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment) were used for the postural analysis of the workers working on the workstation. Video recordings on various activities of the workers was prepared and then images were taken from it for the analysis. The results of RULA and REBA assessment worksheets first showed major signs of risk to the health of workers and after suggesting a suitable mechanism , again the results were calculated which showed signs of low risk comparatively. This led to an increase in the productivity of the manufacturing company and also reduced the fatigue of workers considerably which is discussed further in the paper.**

Keywords:- Ergonomics, MSD, RMD, fatigue, RULA, REBA

Introduction

The human worker plays a significant role as an operator in modern and complex manufacturing systems. Many aspects of industrial work are of physical nature, especially manual tasks, e.g. when the human worker has to lift a component with considerable weight or arrange it in the assembly position. The prevalence of musculoskeletal disorders (MSDs) in workplaces is a major problem. Several studies have been conducted to assess exposure to ergonomic risk factors in worker populations. Thus, developing certain assessment tools for the identification and evaluation of potentially hazardous tasks and postures is crucial for ergonomics researchers. Numerous assessment tools are present for evaluating the work postures of workers such as Quick Exposure Checklist (QEC), Manual Task Risk Assessment tool (manTRA), Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), Ovako Working posture Assessment System (OWAS), Loading of Upper Body Assessment (LUBA), Strain Index, Liberty Mutual Manual Material Handling Tables (SNOOK tables) and the National Institute of Occupational Safety and Health (NIOSH) lifting equation.

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Out of these RULA and REBA are the most preferred assessment tools. The major goal of boosting ergonomics intervention is continuous improvement, the only factor that drives success and competition in the market. Moreover, the organization has the capacity to reduce costs and increase satisfaction of the professional staff through implementation of potential improvement measures resulted after an ergonomic evaluation of its activities and processes.

LITERATURE REVIEW

From ergonomics point of view, manual material handling is a high risk activity that could cause spinal injuries. From physiology perspective, manual material handling requires high amount of energy and strength. Hence, all activities, if carried out inaccurately, could cause inflammation at the nerves and muscles (Muslimah et al., 2006). MMH activities that require high physical demands, continuous bending, crouching and hip twisting could disturb the musculoskeletal system (Deros et al. 2010a; Deros et al. 2010b; Deros et al. 2011; Ismail et al. 2009). The main source of this problem is enduring static loads frequently for long duration, which causes tensions or disruptions on the joints, ligaments and tendons. These are known as Musculoskeletal Disorders (MSD). A preliminary bibliographical analysis enables us to describe the domain of comfort function as the set of angle values that characterizes the movements of human joints Range of Motion (ROM). ROM strongly depends on the subset of values corresponding to a good ergonomic level (not necessarily a comfortable one). In previous studies (Thompson Jon, 2010; Lantz et al., 1999; AMA Guide, 1988; Boone and Azen, 1979; Greene and Wolf, 1989; Luttgens et al., 2011; Koley and Singh, 2008; AAOS-Chicago, 1965; Norkin and Joice White, 2009), several Range of Motion (ROMs) were defined or suggested for each joint. A study conducted on the 'Innovative system for real-time ergonomic feedback in industrial manufacturing' (Nicolas Vignais , Markus Miezal , Gabriele Bleser , Katharina Mura , Dominic Gorecky , Frédéric Marin) presented an innovative system permitting real-time ergonomic feedback and evaluation in industries. Based on a biomechanical model of the upper body and parameter estimation from body-worn IMU and goniometer data, RULA score computations have been carried out to assess the risk of exposure to MSDs in real-time during the movement.

A case study conducted by N. A. Ansari, Dr. M. J. Sheikh on 'Evaluation of work Posture by RULA and REBA' sheds light on evaluation of body posture has been carried out for this particular manufacturing unit by RULA and REBA tools, and can be concluded that; significant proportion of the workers are working in awkward and distressing postures. ‘Influence of musculoskeletal pain on workers' ergonomic risk-factor assessments’, a study conducted by Marie-Eve Chiasson , Daniel Imbeau , Judy Major , Karine Aubry , Alain Delisle, measured the impact of pain on workers' assessment of their workstation. The observations show that workers informing pain assessed their workstations negatively with respect to particular aspects relevant to ergonomic risk factors as desribed by the FIOH Ergonomic Workplace Analysis method, developed for practitioners.

THEORY

This paper emphasizes on the numerical and experimental procedure for establishing a comfort evaluation method for the upper part of the human body. It demonstrates that this approach allows us to determine a quantitative method for comfort measurement, which is universal and can be applied to several industrial cases: workplace environments, automotive passenger compartments, and industrial assembly lines. It can also be used in both the design phases and the optimization and redesign stages of products and processes in order to improve the postural comfort of users/workers.

Objectives of RULA and REBA:

- Develop a postural analysis system sensitive to musculoskeletal risks in several tasks.
- Divide the body into segments to be coded individually, with reference to movement planes.
- Provide a tally system for muscle activity caused by static, dynamic, rapid changing or awkward postures.
- Indicates that coupling is important in the handling of loads but may not always be through hands.
- Give an action level with an indication of criticality.
- Require minimal equipment - pen and paper method.

A. RULA

The method of application of the method is as follows:

- Determine cycle times and monitor the worker for several cycles.
- Determining, for each position, if the left or right side is to be evaluated (in case of doubt both will be considered).
- Determine the scores for each body part.
- Get the final score of the method and performance level to figure out the risks.
- Check the scores of the different body parts to determine where you need to apply corrective measures.
- Refurbish the post or changes to develop posture if necessary.
- If you have made changes, reassess the position with RULA method to check the validity of the improvement.

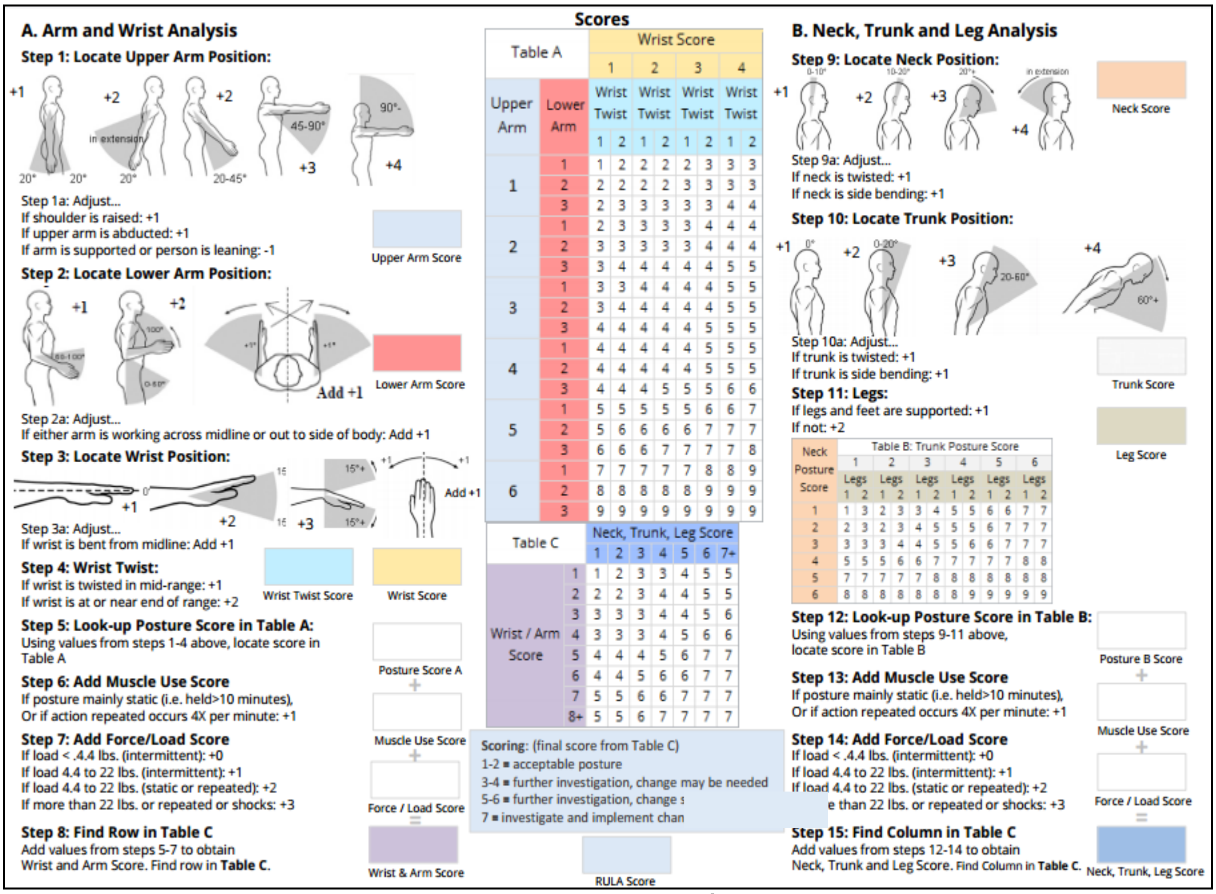

Fig. 1 RULA Assessment Chart

B. REBA

It involves developing a postural analysis system susceptible to musculoskeletal risks in a variety of tasks.

The method of application of the method is as follows:

- Determine cycle times and observe the worker for several cycles.
- Determining, for each position, if the left or right side is to be evaluated (in case of doubt both will be assessed).
- The REBA worksheet is divided into two body segment sections labelled A and B. Section A (left side) covers the neck, trunk and legs.
- Section B (right side) includes the arm and wrist.
- This division of the worksheet ensures that any uncomfortable or constrained postures of the neck, trunk or legs which might affect the postures of the arms and wrist are included in the evaluation.
- Score Group A (neck, trunk and legs) postures, then score Group B (upper arms, lower arms, and wrists) postures for left and right.
- For each stage, there is a posture scoring scale and additional modifications which need to be considered and accounted for in the score.

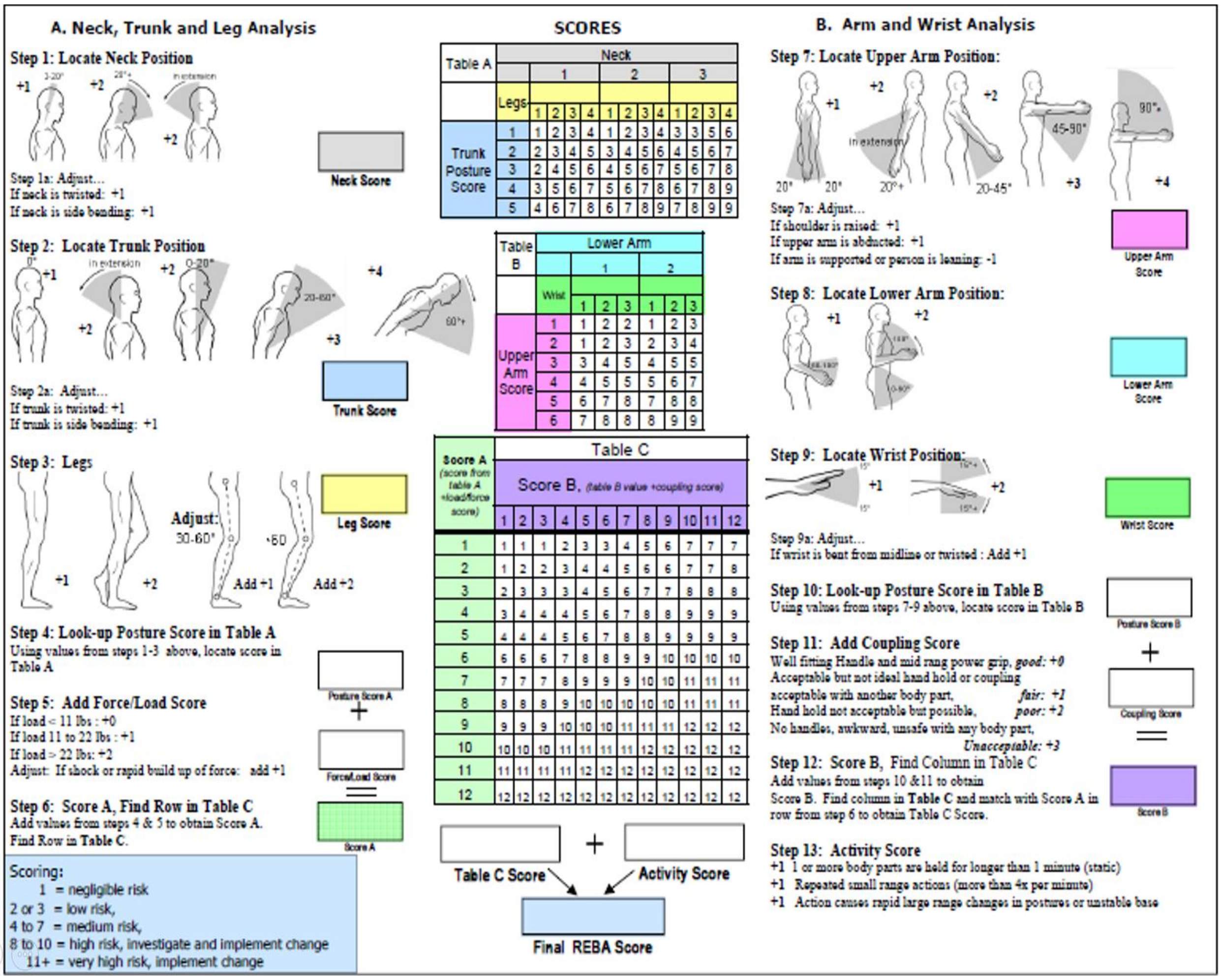

Fig. 2 REBA Assessment Chart

METHODS AND DATA ANALYSIS

This research study was conducted in Bharat Forge Ltd. (Maharashtra). 5 workers were selected for study of average stature 1.673m ±0.27 S.D. (Standard Deviation), average age 35.7 years ±3.02 S.D., average weight 63.5kg ±6.65 S.D. and average experience 11.3 years. Retainers weighing 200kg were assembled on the shop floor due to which workers had to bend a lot which caused fatigue. Video of their postures showing movements of the workers handling the retainers was recorded. After recording, the video was cropped to get snapshots for the analysis of posture of the worker. Snapshots of 5 workers performing their work were obtained. The snapshots were analyzed to fill the scores in RULA and REBA; score sheets. The first step was overall body posture assessment using REBA method. Immediate corrective actions and necessary changes were recommended for activities scored higher to keep away from any risk. To define the initial body segment codes, specified simple tasks were analyzed with variations in the load, movement distance and height. Data was collected and analyzed using RULA and REBA.

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ACTUAL SITE PHOTOGRAPHS

Fig. 3 Bending to move the retainer part

Fig. 4 Cleaning of retainer base

Fig. 5 Lifting of retainer part

Fig. 6 Assembly of retainer

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Parameters	Figure No. 3		Figure No. 4		Figure No. 5				Figure No. 6			
					Worker 1		Worker 2		Worker 1		Worker 2	
	L	R	L	R	L	R	L	R	L	R	L	R
Upper Arm Position	2	2	4	1	1	1	1	1	2	2	3	3
Lower Arm Position	2	2	1	1	2	2	2	2	2	2	2	2
Wrist Position	2	2	2	2	2	2	2	2	2	2	3	3
Wrist Twist	1	1	1	1	1	1	1	1	1	1	1	1
Posture Score (Table A)	3	3	4	2	2	2	2	2	3	3	4	4
Muscle Use Score	0	0	1	1	0	0	0	0	1	1	1	1
Force/Load Score	3	3	0	0	3	3	3	3	3	3	3	3
Wrist & Arm Score	6	6	5	3	5	5	5	5	6	6	8	8
Neck Position	4	4	3	3	4	4	4	4	5	5	2	2
Trunk Position	4	4	3	3	4	4	4	4	4	4	4	4
Legs	1	1	2	2	1	1	1	1	1	1	1	1
Posture Score (Table B)	7	7	5	5	7	7	7	7	8	8	5	5
Muscle Use Score	0	0	1	1	0	0	0	0	1	1	1	1
Force/Load Score	3	3	0	0	3	3	3	3	3	3	3	3
Neck, Trunk & Leg Score	10	10	6	6	10	10	10	10	12	12	9	9
RULA Score	7	7	7	5	7	7	7	7	7	7	7	7
Risk Level	Very High			Medium	Very High							

Table no.1 RULA Score Table (Before)

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Parameters	Figure No. 3		Figure No. 4		Figure No. 5				Figure No. 6			
					Worker 1		Worker 2		Worker 1		Worker 2	
	L	R	L	R	L	R	L	R	L	R	L	R
Neck Position	2	2	2	2	3	3	3	3	3	3	2	2
Trunk Position	4	4	4	4	4	4	4	4	4	4	4	4
Legs	1	1	4	4	2	2	2	2	2	2	1	1
Posture Score (Table A)	5	5	8	8	7	7	7	7	7	7	5	5
Force/Load Score	3	3	0	0	3	3	3	3	3	3	3	3
Score A	8	8	8	8	10	10	10	10	10	10	8	8
Upper Arm Position	2	2	4	1	1	1	1	1	2	2	3	3
Lower Arm Position	2	2	2	1	2	2	2	2	2	2	2	2
Wrist Position	1	1	1	2	1	1	1	1	1	1	3	3
Posture Score (Table B)	2	2	5	2	1	1	1	1	2	2	5	5
Coupling Score	2	2	1	1	2	2	2	2	3	3	3	3
Score B	4	4	6	3	3	3	3	3	5	5	8	8
Activity Score	9	9	10	8	10	10	10	10	11	11	10	10
Table C	1	1	1	1	1	1	1	1	1	1	1	1
REBA Score	10	10	11	9	11	11	11	11	12	12	11	11
Risk Level	High		Very High	High	Very High							

Table no.2 REBA Score Table (Before)

SUGGESTED MECHANISM

The table shows that the maximum number of workers are at a high risk level and need an investigation and change immediately. The results of the posture analysis using RULA is shown in Table 1 and using REBA is shown in Table 2. These results reveal that a risk level exists in most of the job postures. The study was done on workers working in a particular section of the industry where maximum cases of worker stress and fatigue were mentioned. The posture analysis was done using the same sequence of RULA and REBA. Using the REBA analysis method, it was observed that the workers were working in unacceptable posture at high risk levels. It was found that, if the workers continued to work in the same posture they suffer from the MSDs related to neck, trunk and wrist in the near future. The workers were suggested to keep their trunk straight while working. Also, in some jobs the workers were bending their trunk to a higher degree which was not acceptable and they needed a necessary change.

A further investigation of the operation for which the assessment was made, concluded that a material handling device such as an electric chain hoist could be assistive to the workers and a suggestion was made to the company. After the installation of the hoist the entire ergonomic assessment was carried out again in order to obtain a comparative study of the RULA and REBA scores.

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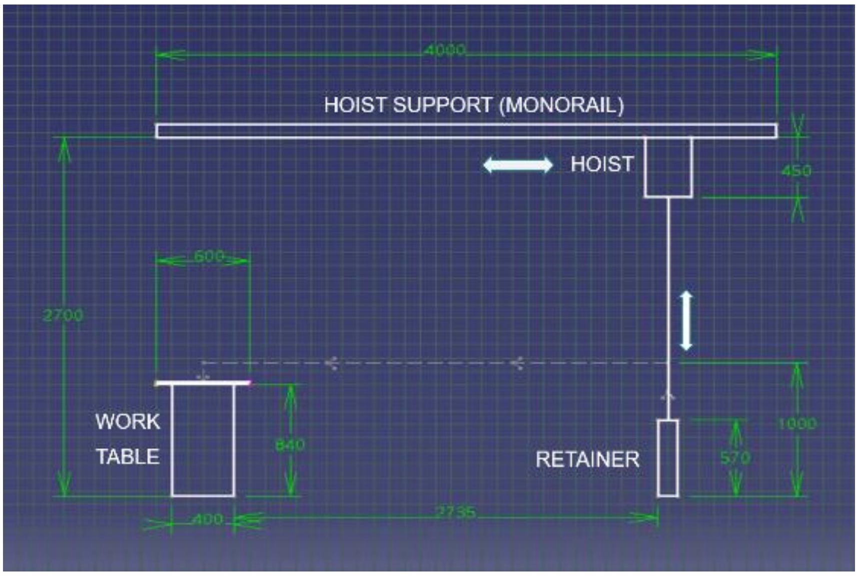

Fig.7 Schematic Diagram of suggested hoist mechanism

Fig. 8 Moving the retainer assembly to the worktable

Fig. 9 Working on retainer assembly

Parameters	Figure No. 8		Figure No. 9	
	L	R	L	R
Upper Arm Position	2	2	1	1
Lower Arm Position	1	1	1	1
Wrist Position	3	3	2	1
Wrist Twist	1	1	1	1
Posture Score (Table A)	3	3	2	1
Muscle Use Score	0	0	0	0
Force/Load Score	0	0	0	0
Wrist & Arm Score	3	3	2	1
Neck Position	1	1	3	3
Trunk Position	2	2	3	3
Legs	1	1	1	1
Posture Score (Table B)	2	2	3	4
Muscle Use Score	0	0	0	0
Force/Load Score	0	0	0	0
Neck, Trunk & Leg Score	2	2	3	4
RULA Score	3	3	3	3
Risk Level	Low			

Table no.3 RULA Score Table (After)

Parameters	Figure No. 8		Figure No. 9	
	L	**R**	**L**	**R**
Neck Position	1	1	2	2
Trunk Position	2	2	2	2
Legs	1	1	1	1
Posture Score (Table A)	2	2	3	3
Force/Load Score	1	1	0	0
Score A	3	3	3	3
Upper Arm Position	3	3	1	2
Lower Arm Position	1	2	1	1
Wrist Position	2	1	1	1
Posture Score (Table B)	4	4	1	1
Coupling Score	0	0	0	0
Score B	4	4	1	1
Activity Score	0	0	0	0
Table C	3	3	2	2
REBA Score	**3**	**3**	**2**	**2**
Risk Level	**Low**			

Table no.4 REBA Score Table (After)

CONCLUSION

Ergonomics, as a concept, implies multiple definitions and perspectives. Due to its interdisciplinary character, ergonomics refers to a wide range of sciences and practical domains. Out of the application domains, this paper focused on identifying MSD risk factors using qualitative and quantitative data. The tools used to assess work tasks (RULA and REBA) were effective.

Observations of the workers performing various tasks suggested that while handling heavy objects, forceful arm and shoulder exertions, extensive bending and working in awkward postures were common this area. The tasks requiring a significant amount of manual work involving upper extremity and low-back activity were found.

Based on RULA observations of work stations and MMH (Manual Material Handling) motions, it was found that the MMH methods used is on level 4. This means that the current method employed should be investigated and immediate changes should be applied. If this method was continued, a higher risk of LBP (Lower Back Pain) and MSD could occur. Fig. 3 to 6 indicate that awkward postures and forceful exertions were the most common MSD risk factors observed. These identification stage were very useful as they generated ideas to reduce risk factors or make the work process less physically demanding and less difficult. The proposed method obtained an efficient ergonomic intervention, based on the needs and particular conditions. Thus, the ergonomic status of the workers working in this area was enhanced which improved the health of the workers by reduced fatigue and risk of MSDs and also optimized the efficiency and the long-term performance of workers which in-turn increased the productivity of the industry.

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