Asian Journal of Managerial Science
ISSN: 2249-6300 (P) Vol.1 No.1, 2012, pp.17-22

DOI: https://doi.org/10.51983/ajms-2012.1.1.1099

An Investigation into Work Postures of Workers Engaged in Casting Industry: A Study in India

Lakhwinder Pal Singh
Department of Industrial and Production Engineering, Dr. B.R. Ambedkar National Institute of Technology, Jalandhar - 144 011, Punjab, India.
E-mail : singh@nitj.ac.in
(Received on 18 September 2011 and accepted on 20 December 2011)

Abstract - **Casting industry in India is appreciably providing employment to more than 5 million people. These are various jobs which may cause musculoskeletal disorders among the working generation. Awkward posture, lifting, forceful movements and manual work at rapid rate contribute to musculoskeletal disorders. Present study is focused on assessing the work posture of workers engaged in different actives of casting units. A video film was recorded in real postures during the various actives performed by the workers. Snaps were cropped after an interval of 10 second for each of the activity. The work postures were evaluated using OWAS, RULA and REBA tools. As per the OWAS assessment, 17% workers required immediately corrective measures and 46% workers needed to correct their postures as soon as possible. In RULA assessment reveals that workers at high and medium risk levels were 64% and 22% respectively. In REBA assessment 27% workers were at very high, 34% workers were high and 32% workers were at medium risk levels. This paper is restricted to only posture analysis on observation based, however application of ergonomics posture could was suggested to the workers. Awkward postures and manual material handing in the workplace should be eliminated. These industries must adopt ergonomics techniques and low cost automation so that workload can be reduced and efficiency can be increased to affect the organizational cost and the society as a whole.**

Keywords : **Work Posture in SMEs, Services, Design for Quality.**

I. Introduction

Ergonomics enhances human performance including the health, safety and productivity of workers. The International Ergonomics Association (IEA) defines ergonomics as; the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Indians live in an ocean of bad ergonomic design. Sadly, almost all good ergonomic design seen in our country is of foreign origin (Gupta, 2004). There is an amazing lack of awareness and knowledge about this field even today. It is the professional and ethical duty of all designers to keep ergonomics above all other considerations, and ensure that the interaction between their design and its final user does not become unpleasant, difficult to use (difficult to reach and clean too), confusing, tiring, illegible, unintelligible, mistake-prone, harmful or dangerous even in the smallest possible way (Gupta, 2004). Shikdar & Al-Hadhrami (2007) reported that flexibility in workstation set-up can eliminate the anthropometric and ergonomic problems of fixed workstations and boost the operator's performance. Erdinc & Vayvay (2008) reported that ergonomics interventions that enhance employee performance lead to better quality in manufacturing. Other study by Balasubramanian *et al.* (2011) reported safe driving places importance on cognitive aspects, such as perception, vigilance, reasoning, judgment as well as efficient motor skills. Cognitive fatigue brings about a loss of attentiveness in drivers, which could be detrimental; decrease in attentiveness can be measured using electroencephalogram (EEG) signals. Balasubramanian *et al.* (2011) provided a single measure of the ergonomic assessment in terms of several factors (e.g. posture, biomechanical forces, environmental, etc.) collectively contributing to ergonomic impairments. This integrated score provides a clearer picture of the risk involved in the job and hence it can be used as a basis for prioritizing operations for ergonomic interventions.

For many years it has been possible to observe the reasons behind injuries in small scale and medium scale industries. In these industries casting process is a physically demanding occupation, the work operations often involve lifting heavy objects, moving and carrying equipment and awkward working postures, all of which are risk factors for back injuries and other musculoskeletal disorders (MSDs). Manual material handling has been known to be one of the prime causes of musculoskeletal disorders (MSDs). The small and medium scale enterprises (SMEs) do not only have contribution in growth of national economy but in spite of all progress bad occupational status, too.

The objective of this study is to analyse the working postures of workers engaged in various processes of small scale casting industry. The study used three assessment tools like Ovaku Work posture Analysis (OWAS), RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment), and recommended the changes to be made in the body posture while working.

OWAS is a method for the evaluation of postural load during work. The OWAS method is based on a simple and systematic classification of work postures combined with observations of work tasks. The method can be applied for the development of a workplace or a work method, to reduce its musculoskeletal load and to make it safer and more productive (Karhu *et al.* 1977).

RULA was developed earlier by McAtamney and Corlett, 1993, to provide a rapid objective measure of musculoskeletal risk caused by mainly sedentary tasks where upper body demands were high; where work related upper limb disorders are reported. RULA assesses the posture, force and movement associated with sedentary tasks such tasks include computer tasks, manufacturing or retail tasks where the worker is seated or standing without moving about. This tool requires no special equipment in providing a quick assessment of postures of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body. A coding system is used to generate an action list which indicates the level of intervention required to reduce the risks of injury due to physical loading on the operator.

REBA (Rapid Entire Body Assessment) was developed by Hignett, S. and McAtamney, L. 2000, to provide a quick and easy observational postural analysis tool for whole body activities (static and dynamic giving musculoskeletal risk action level. The development of REBA is aimed to divide the body into segments to be coded individually with reference to movement planes. It provides a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures. It reflects that coupling is important in handling of the loads but may not always be via the hands. It also gives an action level with an indication of urgency.

II. Literature Survey

Manual material handling is one of the major causes of severe industrial injury. Foundries are an industry where manual material handling is performed routinely. For the last four decades various studies have been conducted on assessment of health related problems and musculoskeletal disorders (MSD). One of the study on women workers in a woollen textile factory found that pain and fatigue are the major problems for the women in the spinning section. The study recommended that ergonomic factors such as provision of backrest and frequent rest periods could remediate the musculo-skeletal symptoms (Karhu *et al.* 1977).

Visual discomfort has a high prevalence for Visual Display Unit (VDU) workers. In three different prospective epidemiological studies, correlation between Visual discomfort and average pain intensity in the neck and shoulder were studied. Three different prospective epidemiological studies have shown that there is a clear indication of a relationship between visual discomfort and pain in the neck and shoulder (McAtamney *et al.* 1993). In an anthropometric survey was carried out for female agricultural workers from north-eastern India, it appeared that most body dimensions are higher in the middle age group and lower with higher age groups and hence, there is a great scope of improving the agricultural tools (Hignett *et al.* 2000). The musculo-skeletal disorders (MSDs) in Chinese restaurant cooks were studied using National Health Insurance data. The most affected body parts was low back with epicondyle and elbow at highest risk (Karhu *et al.* 1977). The highest prevalence was reported in lower back, knees and upper back and recommendations were made for elimination of awkward postures and manual material handling (Moen, S. Torp, 2005) . A relationship between work-related factors and disorders in neck-shoulder and low-back region among male and female ambulance personnel was studied. Technical improvements such as design of ambulance vehicles were needed to facilitate physically demanding tasks along with psychosocial work environment in the ambulance service (Singh *et al.* 2010). Cleaning is associated with high physical and psychosocial workloads and musculo-skeletal disorders related to it were studied. A few studies concern equipment design, working environments and factors affecting individual workers. A need to conduct research on cleaning tools/equipment, working environments and individual risk factors is apparent Singh *et al.* 2008). The Strain Index to Analyze Jobs for Risk of Distal Upper Extremity Disorders was developed. Three different studies have shown that it is capable of identifying jobs with no distal upper extremity morbidity as “safe” and jobs with distal upper morbidity as “hazardous.” The results provide evidence of the Strain Index's generalizibility and predictive validity (Fredericks *et al.* 2008). A study was conducted to modify an existing data reduction method for directly quantifying physical exposures during variable non-cyclic work. CEVA (Clustered Exposure Variation Analysis) is a useful modification of EVA (Exposure Variation Analysis) for contrasting the non-cyclic work typical of understudied industries like construction. A simplification of electromyography with summary measures such as CEVA provides a comprehensible, yet accurate measure of forceful exertions during work tasks (Hutchinson TP, 2008). This study investigated the effects of implementing or improving occupational H&S management on the work environment, H&S-related behavior and musculoskeletal health of workers in small and medium-sized companies. The satisfactory result was come out in companies with improved H&S management from baseline to follow-up reported increased satisfaction

with the H&S activities at the garage; improved support from management and colleagues; improved health-related support and control; and increased participation in H&S activities (Metgud *et al.* 2008). OWAS method of postural analysis classifies that the postures adopted by the workers while performing the tasks of casting and grinding are very awkward. The frequency of load lifting in these workers is much more and thus it further puts the workers into more stressed conditions of work (Kilbom *et al* .2001). According to the Strain Index method the workers of small scale forging industry were found with higher risk of distal upper extremities disorders (DUE) (Krause *et al.* 2004).

III. Material And Method

The study was carried out in a small scale casting unit in Punjab and observations were made in different sections of the casting unit. It was observed that in various casting operations like pattern making, mould making, core making, molding, sand preparation, and molten metal pouring etc, people are dealing with hazardous postures. Few problem areas were identified based on observation made over the operations and operating conditions. A video film was recorded on different casting operations with the emphasis over the each activity. After recording the video, the snapshots were cropped after every ten seconds of time gap. The snapshots of 100 in numbers were cropped in such a way that a range of postures of body parts in the activities were clear to observe. The snapshots were analyzed to fill the scores in OWAS, RULA and REBA; score sheets (Figure 1-3). As a protocol of the study, the first step was overall body posture assessment using OWAS method. The jobs with the involvement of high risk were numbered higher and those with less risk involvement were numbered 1. Immediate corrective actions and necessary changes were recommended for activities numbered higher to avoid any risk. The upper limbs mainly arms and wrist of (both the sides; left and right) posture was assessed using RULA score sheet; the range of movement for each body part is divided into sections. These sections are numbered so that the number 1 is given to the range of movement or working posture where the risk factors present are minimal. Higher numbers are allocated to parts of the movement range with more extreme postures indicating an increasing presence of risk factors causing load on the structures of the body segment. The exposure scores according to RULA were divided into four exposure categories: negligible, low, medium and high. Medium and high risk actions should be urgently addressed to reduce the level of exposure of risk factors. For those activities where whole body and limbs motion needs to be assessed REBA was used which is also a pen paper technique. In REBA the body parts are divided into sections and each body part is scored according to its range of movement. Higher scores are given to the body parts where presence of risk factors are more and lower scores are given to those where presence of risk factors are minimal. The REBA scores were divided into five categories: negligible, low, medium, high and very high. Medium, high and very high needed an immediate action to avoid any musculoskeletal disorder.

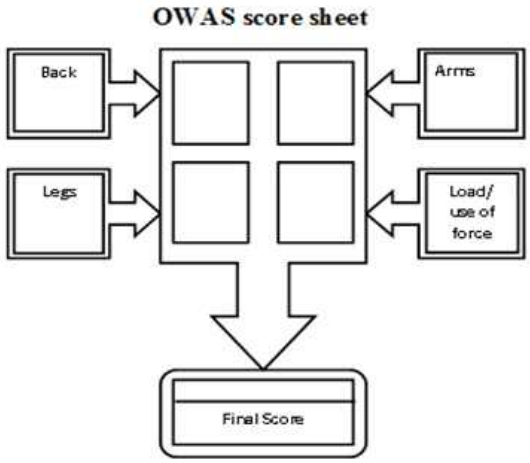

Fig.1 OWAS score sheet

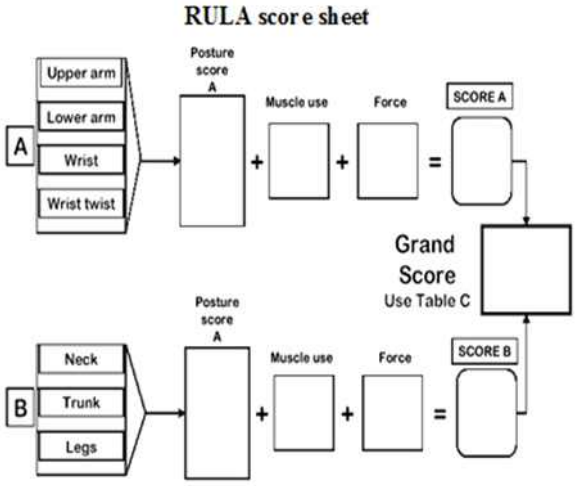

Fig. 2 RULA score sheet

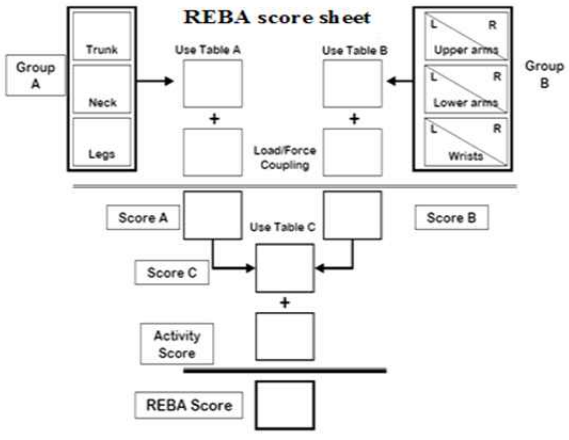

Fig. 3 REBA score sheet

IV. Results and Discussion

The scores obtained from three risk analytical tools are tabulated in terms of risk level, action and percentage of workers using left or right hand. Table 1 reveals scoring data of OWAS analytical tool, 17% workers are working in very bad working place and working methods and therefore corrective measures should be taken immediately. Data shows that 46% and 17% workers are involved in various operations and therefore corrective measures should be taken as soon as possible and in the near future and 20% workers have satisfactory working conditions and therefore no corrective measures is to taken. Table II shows scoring data of RULA analytical tool, 61.40% workers using left hand and 67.82% workers using right hand are exposed to high level of risk and MSDs. These adopted an awkward posture and an investigation is needed to do the operations effectively and this posture should be change immediately. Similarly, 25% and 13.60% workers using left hand and 19.54% and 12.64% workers using right hand are exposed to medium and low level of risk respectively. From these data sets it is recommended as soon change should be done and investigates further to do work effectively. Table II shows scoring data of REBA analytical tool, 26.40% and 27.70% workers using left hand and 35.20% and 33.70% workers using right hand are exposed to very high and high level of risk respectively. From these data sets it is recommended as immediate necessary and soon change should be done to reduce level of exposure to risk and MSDs. Similarly, 32.90% and 32.50% workers using left hand and 5.50% and 6.10% workers using right hand are exposed to medium and low level of risk respectively. From these data sets it is recommended as necessary actions have to be taken and for second data set it may be necessary to take further actions.

Table I Risk level determined using OWAS

OWAS Score	Action	No. of Workers	% of Workers
1	No corrective measures	20	20.00
2	Corrective measures in the near future	17	17.00
3	Corrective measures as soon as possible	46	46.00
4	Corrective measures immediately	17	17.00
Total		100	

Table II Risk Level Determined Using Rula

RULA Score	Risk Level	Action	No. of Workers		% Workers	
			L	R	L	R
1-2	Negligible	Acceptable	-	-		
3-4	Low	Investigate further	12	11	13.60	12.64
5-6	Medium	Investigate further and change soon	22	17	25.00	19.54
7	High	Investigate and change immediately	54	59	61.40	67.82
Total			88	87		

Table III Risk Level determined using REBA

REBA score	Risk Level	Action	No. of Workers		% Workers	
			L	R	L	R
1	Negligible	None necessary	-	-	-	-
2-3	Low	May be necessary	05	05	05.50	06.10
4-7	Medium	Necessary	30	27	32.90	32.50
8-10	High	Necessary soon	32	28	35.20	33.70
11-15	Very high	Necessary now	24	23	26.40	27.70
Total			91	83		

Fig. 4 Workers Performing various activities in awkward postures

TABLE. IV PROCESS-WISE DISTRIBUTION OF OWAS SCORE

Process	Scores			
	1	2	3	4
Mould making	4	5	10	7
Mould lifting	9	4	20	2
Pattern making	1	1	5	-
Molten metal lifting/carrying to mould box	2	1	3	-
Molten metal pouring	4	6	8	8

The entire process of casting unit can be categorized as five main processes which are mould making, mould lifting, pattern making, molten metal lifting to mould box, molten metal pouring. According to OWAS, no awkward posture and high level of risk are found in pattern making process and molten metal lifting/ carrying to mould box process. In mould making process 41.17% workers are at high risk and therefore, corrective measures need to be taken immediately. Similarly, 21.73% workers are at medium risk, 29.41% workers are at low risk l and 20% workers are at negligible risk level and corrective measures need to taken accordingly. In case of mould lifting 11.76% workers are at high risk, 43.47% workers at medium risk, 23.52% workers at low risk and 45% workers at negligible risk level. Similarly, in pattern making process 10.86% people are at medium risk, 5.88% are at low risk and 5% are at negligible risk. In molten metal lifting to mould box process 6.52% people are at medium risk, 5.88% are at low risk and 10% are at negligible risk. In process of molten metal pouring about 47.05% employees are under severe level of risk which is a big count, so immediate actions are needed. Similarly, 17.39% workers are at medium level of risk, 35.29% are at low level of risk and 20% are at negligible level of risk. Thus, according to severity of job postures the corrective measures are needed.

TABLE V PROCESS-WISE DISTRIBUTION OF RULA SCORE

Process	Scores							
	1-2		3-4		5-6		7	
	L	R	L	R	L	R	L	R
Mould making	-	-	-	-	9	6	13	15
Mould lifting	-	-	8	8	3	3	17	19
Pattern making	-	-	-	-	4	2	2	5
Molten metal lifting to mould box	-	-	-	-	2	1	4	5
Molten metal pouring	-	-	4	3	4	5	17	20

According to RULA, in this casting unit in mould making process 24.74% workers are at high risk, therefore a keen investigation is needed and posture should change immediately. Also, in this process 38.09% workers are at medium risk level, therefore further investigation is needed. In process of mould lifting with the help of mechanical equipments 31.84% workers are at high level of risk, 15.63% are at medium level of risk and 69.69% are at low level of risk. The corrective actions are recommended accordingly. Similarly, in process of pattern making only 6.08% workers are at high level of risk, and only 14.97% workers are at medium level of risk, and therefore suitable actions are in demand. In process of molten metal lifting/carrying to mould box 7.93% workers are engaged in jobs with awkward postures and are at high level of risk, likewise 7.48% people are at medium level of risk. In molten metal pouring about 32.68% employees are doing their jobs at the cost of health having adverse effect on body causing MSD's so, at high risk level, hence some remedial actions, automation and ergonomics techniques should be adopted. In the same process 23.79% workers are at medium risk level and 30.30% are at low level of risk.

According to REBA, 59.59% workers from mould making process are at very high level of risk, that's why remedial actions and initiative steps should be taken immediately and 28.12% workers are at high level of risk, so actions should be taken soon. Similarly 15.73% workers are at medium risk level and 20% workers are at low risk level. In the process of mould lifting 12.77% workers are at very high risk, 41.51% workers are at high risk, 36.84% workers are at medium level of risk and 70% workers are at low level of risk and thus as per severity of risk necessary actions have to be taken. The process of pattern making involve 4.25% employees at very high risk level, 11.60% employees at high risk level and 5.36% employees at medium level risk. Molten metal lifting to mould box is the process involve a long movement with heavy workload, about 4.25% workers engaged in this process are working at very high level of risk and therefore ergonomics training, conveyer techniques and other necessary actions are to be taken. In this process 6.69% workers are at high level of

risk and 10.55% are at medium level of risk. In the other process of molten metal pouring which is to be mentioned as quite laborious work 42.56% workers are at very high level of risk among all the workers under this category. Similarly 13.61% workers are at high level of risk and 31.47% workers are at medium level of risk. The remedial action should be taken for the people at high level of risk as soon as possible.

TABLE VI PROCESS WISE DISTRIBUTION OF REBA SCORE

Process	Scores									
	1		2-3		4-7		8-10		11-15	
	L	R	L	R	L	R	L	R	L	R
Mould making	-	-	1	1	5	4	10	7	7	7
Mould lifting	-	-	3	4	11	10	14	11	3	3
Pattern making	-	-	-	-	1	2	4	3	1	1
Molten metal lifting to mould box	-	-	-	-	3	3	2	2	1	1
Molten metal pouring	-	-	-	-	10	8	3	5	10	10

V. CONCLUSION

This study reveals that the workers of in small and medium scale enterprises (SMEs) are at high risk of musculoskeletal disorders. Awkward postures and manual material handing in the workplace should be eliminated & small and medium scale industries should adopt ergonomics techniques and automation techniques like installation of mechanical aids such as pneumatic lifts, conveyors, and/or automated material handling equipment will undoubtedly decrease the risk of injuries and musculoskeletal disorders (MSDs) for workers employed by foundries and therefore workload can be reduced and efficiency can be increased to put the effect to organizational cost and the society as a whole. It is recommended as the distance of carrying molten metal in crucibles should be diminished and there should be a proper training of metal pouring by ergonomics techniques and well defined plant layout.

REFERENCES

[1] V. Balasubramanian, A. Adalarasu and A. Gupta, "EEG based analysis of cognitive fatigue during simulated driving", *International Journal of Industrial and Systems Engineering ,* Vol. 7, No.2 pp. 135 - 149, 2011.

[2] V. Balasubramanian, TT. Narendran, V.S. Praveen, "RBG risk scale: an integrated tool for ergonomic risk assessments", *International Journal of Industrial and Systems Engineering,* Vol. 8, No.1, pp. 104 - 116, 2011.

[3] P. Chandna, S. Deswal, A. Chandra, *An anthropometric survey of industrial workers of the northern region of India* , 2010.

[4] O. Erdinc, O.Vayvay, "Ergonomics interventions improve quality in manufacturing: a case study", *International Journal of Industrial and Systems Engineering*, Vol. 3, No. 6 pp. 727 - 745, 2008.

[5] L. McAtamney and E.N. Corlett, "RULA: a survey method for the investigation of work related upper limb disorders", *Applied Ergonomics,* Vol. 24, pp. 91-99, 1993.

[6] S. Hignett and L.McAtamney, "Rapid Entire Body assessment (REBA)", *Applied Ergonomics,* Vol. 31, pp. 201- 205, 2000.

[7] O. Karhu, P. Kansi and I.Kuorinka, "Correcting working postures in industry: a practical method for analysis. *Applied Ergonomics,* Vol.8, No.4, pp. 199-201.

[8] S. Moen Torp, "The effects of occupational health and safety management on work environment and health: A prospective study", Faculty of Health Science, Vestfold University College, Department of Public Health and Primary Health Care, Norway, 2005.

[9] L.P.Singh, A. Bhardwa, K.K. Deepak and S. Sahu, "Small & medium Scale Casting and Forging Industry in India: an ergonomic study, *Ergonomics,* Vol. 22, No.1, 2010.

[10] L.P.Singh, A. Bhardwaj, K.K.Deepak and S. Shahu, " Evaluation of Work Strain on Workers Working in Small Scale Forging Industry," *Journal of Environmental Physiology,* Vol. 1, No.20, pp.83-92, 2008.

[11] T.K. Fredericks, A.R. Kumar and S. Karim, " An ergonomic evaluation of a manual metal pouring operation", *International Journal of Industrial Ergonomics,* Vol. 38, pp.182–192., 2008.

[12] T.P. Hutchinson, "On ratings of comfort and exertion by visual display unit users and ratings of workplace layout and working posture by expert ergonomists", *Applied Ergonomics,* Vol. 39, No. 1, pp. 131-132, 2008.

[13] D.C. Metgud, M.G. Mokashi, P.N. Saha and S. Khatri, "An ergonomics study of women in a woolen textile factory for identification of health-related problems", *Indian J. Occup Environ Med.,* Vol. 12, No.1, pp. 14–19, 2008.

[14] A. Kilbom, E.V. Juntura, N.Fallentin and M.Waersted, "Evaluation of physical workload standards and guidelines from a Nordic perspective", National Institute of Occupational Health Copenhagen, Denmark, Finnish Institute of Occupational Health Helsinki, Finland, National Institute of Occupational Health Oslo, Norway, National Institute for Working Life Stockholm, Sweden, *Scand J Work Environ Health ,* Vol. 27, pp. 21-52, 2001.

[15] N.Krause, Rs.Rugulies and S.L. Syme, 'Physical Workload, Ergonomic Problems, and Incidence of Low Back Injury: A 7.5-Year Prospective Study of San Francisco Transit Operators", Department of Medicine, University of California, San Francisco, National Institute of Occupational Health, Denmark, Department of Epidemiology and Biostatistics, School of Public Health, University of California, Berkeley", *American Journal of Industrial Medicine,* Vol. 46, pp.570-585, 2004.