5.7. Ergonomic intervention of workstation for plane user in carpentry task:

Carpenters usually do different tasks in their workshops. In this present ergonomics investigation three major tasks (chiseling, planning and sawing) have been taken. For executing those tasks there was no specific work station for chiseling and saw operating. Those workers were used to do their work by sitting on the floor or by standing in a nonspecific work space. However, the hand plane users had a certain workstation in which they used to execute their tasks. There was a working platform made up of a wooden frame for their work. In conventional carpenters workshop the workstation, that is, the wooden platform was made without considering the ergonomics principles. Ergonomics intervention might be helpful for possible betterment of the work condition.

From the human factors point of view, there were some disadvantages in the conventional workstation for the plane user. For instance, the prime problem of this working platform was that here was no standard working height for planning work. The physical dimensions of working platform for planning task were found to vary widely. As a consequence, the workers were exposed to postural stress. They were sometimes required to bend forward when the work surface height was too low or to raise their shoulder for long time in case of too high work surface height. Such postural condition might induce biomechanical stress in body joints and enhance segmental ache among the workers. To overcome the said problems, it was necessary to improve or optimize the height of workstation for plane users.

The following are purposes for evaluating the workstation:

- To modify the working posture
- To lessen musculoskeletal difficulties in different body segments
- To surge efficiency of the workers

Thus, considering ergonomics principle an effort has been made to optimize the workstation height for the carpenters to perform planning task. The planning workstation was composed of a working platform made of wood on which shaping of wood were done by the help of a carpenter’s hand plane. The working platform had different measures, viz., length, breadth, height etc. Among these measures working height of the platform was the most important because work posture was related to it. In this study, main emphasis has been focused to optimize the work surface height of the workstation for hand plane users. The following steps were undertaken for modifying the workstation for hand plane operation.

5.7.1. Evaluation of existing workstation

The conventional workstation was assessed by the subjective assessment along with by some objective measures also. Ten traditional workstations were chosen, and their physical dimensions were measured. The measures were presented in Table 5.52. The workstation used for planning work was found to differ in their dimensions because this type of workstation was made by the local carpenters as per their ideas and requirements, no specific standard was followed for making the workstation.

Table 5.52: Physical dimension of workstation used by carpenters during planning task

Workstation No.	Height (cm)	Length(cm)	Breadth(cm)
1	60.2	152.0	69.2
2	62.5	161.4	65.7
3	57.3	166.6	67.5
4	56.7	151.1	79.3
5	62.5	160.9	68.2
6	55.9	155.2	69.2
7	60.5	136.6	69.0
8	62.4	142.2	74.4
9	63.2	145.1	61.5
10	61.9	158.1	66.8
Mean±SD	**60.3±2.72**	**152.92±9.44**	**69.08±4.83**
Range	55.9-63.2	136.6-166.6	61.5-79.3

The posture adopted by the carpenters during work was related to the physical dimensions of the existing workstation. It was observed that the plane users were used to adopt awkward posture; they had to perform their task with repeated movement of the body and to adopt bent forward. Results (Table 5.52) showed that the mean height of the existing workstation was 60.3 cm, which seemed short enough for the target group of workers. Inappropriate height of workstation might be a valid reason for feeling discomfort in back and shoulder. The mean length and breadth of the workstation was 152.92 cm and 69.08 cm respectively. The higher dissimilarity of length and breadth might be reasons for type of task and also for the availability of space. Sometimes the length/ breadth of the workstation was dependent on the number of workers performing their task in the same work station at a time.

5.7.2 Study of musculoskeletal disorder (MSD) and Body Part discomfort rating (BP)

Assessing the musculoskeletal disorder (MSD) and Body Part Discomfort rating (BPD) was the evaluating parameters for finding out the difficulties of using existing workstation. During operating the hand plane, body part discomfort (BPD and prevalence of MSD of the workers was evaluated by employing the method which has already been discussed in the methodology section (Section IV). From the results of the study of MSD (Table 5.53) it was observed that a higher percentage of hand plane users were suffering from pain / discomfort in shoulder (82.63%), neck (75.3%) and lower back (70.63%) regions of the body. From the results it was also illustrated that 87% of plane operator stated pain / discomfort during performing the planning task. Types of pain and their occurrence were also studied during performing work by a questionnaire method. The results of this study have been shown in Table 5.54. It was observed that in 87% of the carpenter had felt overall pain in their body during working the existing workstation. Moderate degree of pain was prevalent (79%) among them. About 79% of the carpenters assumed that such health problems occurred due to using inappropriate height of workstation. In addition, more than 70% of the workers reported felling of uneasiness till end of the work. So, it appeared that incompatibility with the height of the workstation might the reason for work related pain or discomfort in shoulder, lower back and other body segments.

Table 5.53:Frequency and Percentage of carpenters reported musculoskeletal problems during performing task in the existing workstation

Body segments	Existing workstation user (n=24)	
	f	%
Neck	18	75.3
Shoulder joint	20	82.63
Elbow joint	15	61.52
Wrist joint	16	65.83
Palm	10	40.5
Fingers	15	61.56
Upper back	9	37.59
Lower back	17	70.63
Hip	14	57.94
Knee	10	40.02

Table 5.54:Types and occurrence of pain / discomfort during performing task in the existing workstation (n=24) [Frequency and percentage (%)]

Parameters studied	Types of Response	Frequency	Percentage (%)
Reported cases of Overall feeling of discomfort/pain	Yes	21	87.5
	No	3	12.5
Types (severity) of discomfort/ pain	Mild pain	2	8.3
	Moderate pain	19	79.2
	Severe pain	3	12.5
Whether discomfort / pain were due to using existing workstation?	Yes	19	79.2
	No	2	8.3
	Doubt about origin of pain	3	12.5
Feeling of Uneasiness endures till the end of work shift		17	70.8
Feeling of uneasiness continues after the work		7	29.2

5.7.3. Evaluation of Users' Satisfaction Regarding Physical Dimensions of conventional workstation:

To find out the users' satisfaction concerning physical dimensions of the conventional workstation during execution of the task in the carpenter workshop, a study was made. To execute this study, 24 subjects were randomly chosen among formerly selected plane user (carpenters). According to alphabetical order of their first names the subjects were selected. The study was made by questionnaire method. The responses of those selected subjects about the appropriateness of the height of conventional workstation were noted. Some alterations in the height of the workstation was proposed by the selected subjects for this study (Table 5.55).From the results it was noted that the majority of the plane users were not in favor of the conventional workstation and desired for alteration in height. Most of the users proposed to increase the height of workstation from that of existing one.

Table5.55 :User satisfaction (Percentage of subjects) on physical dimensions of existing workstation (n=24)

Question asked		Physical dimensions of workstation		
		Height (cm)	Length(cm)	Breadth(cm)
Whether height of existing workstation is appropriate for work or not?	Yes	17.7%	78.6%	74.2%
	No	82.3%	21.4%	25.8%
What modification do you suggest?	No change	17.7%	78.6%	74.2%
	Increase	76.7%	21.4%	23.2%
	Decrease	5.6%	0.0	2.6%

5.7.4. Design Approach:

For the modification of carpenter's workstation, a design concept was developed in accordance to some alterations which were suggested by the user. The main importance was given to optimize the height of the work surface for executing the planning task at carpenter's workshop. To overcome the problem of working height, which was inappropriate of wood planning task, the height existing workstation was increased in three steps and assessment was made for the same. By changing the work surface height of the workstation from that of existing one, three prototypes were prepared. It was observed that the mean height of the of existing workstation was60.3 cm (**Table 5.52**). The height of the additional three prototypes wereselectedas65cm, 70cm and 75cm and finally three prototypes, viz., MW1, MW2, MW3were made and the existing workstation with a height of 60 cm(EW) was also used for the evaluation.

5.7.5. Evaluation of prototypes:

Some simulation studies were made for the assessment of prototype models of the workstation. To find out the suitability of using the altered workstations the fabricated prototypes were given to the plane operating workers and asked to perform the tasks. The paired comparison test, biomechanical studies as well as study of productivity ware made to evaluate the compatibility of prototypes to the uses.

Table 5.56 :**Anthropometric measures and Percentile values of the workstation users (n=70) in carpentry task**

Anthropometric Parameters		Mean ±SD	5th Percentile values	95th Percentile values	Selected percentile
Elbow height(cm)	Right	97.85 ± 9.29	**75.7**	109.84	5th
	Left	97.88 ± 9.29	**75.65**	110.0	5th
Forward arm reach(cm)	Right	73.43 ± 6.27	59.89	**86.25**	**95th**
	Left	75.09 ± 12.85	58.13	**86.65**	**95th**
Functional Arm Reach, horizontal (cm)	Right	65.74±3.56	41.12	**69.21**	**95th**
	Left	65.71±3.45	42.16	**69.06**	**95th**

Table 5.57 :Height of existing and modified workstations:

Workstations	Height of the workstations	
Existing	**EW**	60.3 cm
Modified	**MW1**	65 cm
	MW2	70 cm
	MW3	75cm

Table 5.58 :Comparison between Physical dimensions of workstation and anthropometric measures

Workstation parameters	Measures	Anthropometric parameters	Measures	Comparison
Height	60.3 cm	Elbow height (5^{th}%ile)	75.7 cm	25.5% lower*
Length	152.9 cm	Functional forward arm reach (95%ile)	69.2 cm	54.7% higher*

*with respect to workstation measure

The suitability of the dimensions of the workstation was assessed by comparing those values with that of anthropometric measures of the users. The elbow height of the users is usually taken as the reference height of the workstation. The 5^{th} percentile value of the elbow height of the carpenters was compared with the height of existing workstation. It was noted from the results (**Table 5.58**) that the height was about 25% lower than that of reference height, that is, elbow height. Thus it appeared that the height of the workstation was not appropriate for the workers. A low working height might compel the worker to adopt forward bending posture during performing the task. On the other hand, the length of workstation was compared with the 95^{th}percentile value of the functional arm reach (horizontal) of the users, the reference anthropometric measure of the users. It was observed that the length of the workstation was much higher (54.7%) than the value of the forward arm reach. The results indicated that the length of the workstation might be appropriate for planning task as there was enough space for operation of hand plane. Therefore, it may be stated that alteration of height of workstation was necessary.

5.7.5.1. Paired comparison test:

For determining an appropriate height of the workstation, paired comparison test was performed. The prototypes were named as EW for existing workstation and MW1, MW2 and MW3 for modified workstation having the height of 60.3 cm, 65cm, 70cm and 75cm respectively. This test was carried out on 24 subjects. The subjects were requested to perform their task using each of the prototype workstations and they were also asked to compare each pair of the prototype for rating in an 11-point scale, as mentioned in the methodology section.

Parameter: height of the workstation
EW: 60.3cm; MW1:65cm; **MW2:**70cm; **MW3:**75cm;

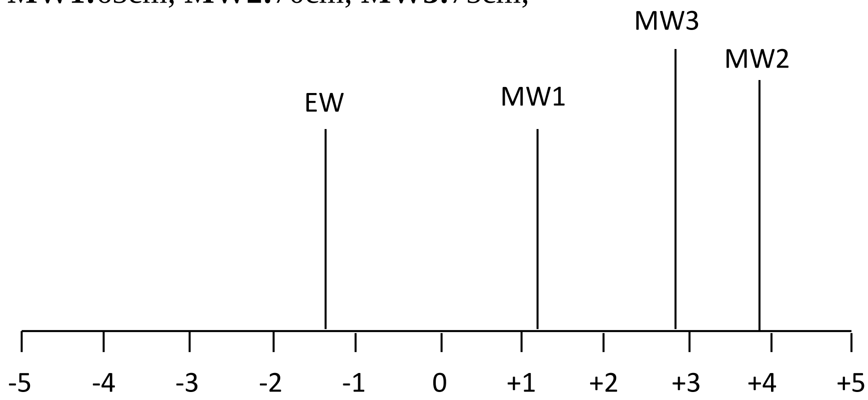

Fig 5.12: Stimuli space of different prototypes for height of workstation

The calculated resultant scores of paired comparison test for every prototype model was plotted in an 11-point scale as presented in Fig 5.12. It was found from the results that the prototype model EW got negative rating and other three modified workstations MW1, MW2 and MW3 had got positive ratings. The highest preference score of the subjects was observed in case of prototype MW2, the height of which was 70 cm. Hence, the results pointed out that the height of the prototype MW2 (70cm) would be appropriate for the users. So, a height of 70cm might be taken as suitable height for wood planning task in carpenter's workshop.

- **Other studies**

Some other studies were also conducted to justify the optimization of work surface height as appeared from the paired comparison test. The results of those studies are discussed in the following subsections.

5.7.5.2. Body Part Discomfort (BPD) rating:

Body part discomfort rating of the hand plane operators was assessed and such rating was done during working in existing and modified workstation on a comparative basis.

Table 5.59 :**Body part discomfort (BPD) rating (Mean ±SD) of carpenters during working in existing and modified models of workstation(n=24)**

Body segments		Different workstation height			
		Existing workstation with a heightof60.3cm	Modified workstation		
			MW1 (height :65cm)	**MW2 (height :70cm)**	**MW3 (height :75cm)**
Neck		**4.67±1.89**	4.57±1.66	3.68±2.11	5.54±1.77
Shoulder	R	**4.98±2.12**	4.60±2.01	3.66±2.18	5.04±1.99
	L	**3.89±2.09**	4.26±2.03	3.37±2.01	3.85±2.05
Upper arm	R	**2.53±2.11**	2.62±2.07	2.37±1.96	2.31±2.13
	L	**2.34±1.99**	1.83±1.81	2.09±1.99	2.69±2.11
Lower arm	R	**1.99±1.49**	2.13±1.75	1.70±1.50	1.92±1.13
	L	**2.12±1.68**	2.23±1.77	1.82±1.64	2.15±1.46
Upper back		**1.85±2.32**	1.89±2.61	0.79±2.21	4.88±2.03
Middle back		**1.32±1.88**	1.47±1.76	0.88±1.94	4.92±1.79
Lower Back		**4.53±1.79**	4.11±1.58	2.46±1.66	5.35±1.96
Buttock		**3.12±2.21**	3.43±2.07	2.57±1.84	3.27±2.62
Thigh	R	**1.84±1.79**	1.94±1.80	1.72±1.66	1.77±1.77
	L	**1.76±1.69**	1.68±1.60	1.70±1.67	1.73±1.71
Cuff	R	**1.91±1.91**	1.81±1.80	1.62±1.88	2.23±1.92
	L	**2.07±1.79**	1.77±1.77	1.59±1.90	2.65±1.57
Feet	R	**1.69±1.60**	1.81±1.62	1.20±1.50	1.92±1.60
	L	**1.43±1.63**	1.40±1.48	1.25±1.53	1.54±1.73
Over all discomfort rating of the body		**2.88±1.88**	2.91±1.83	2.33±1.83	3.16±1.84

The workers were requested to execute their task with each prototype and to express their opinions concerning the degree of pain / discomfort occurred during the work in different parts of the body in a 10-point scale. The scores given by the users about their feeling of discomfort / pain have been presented in Table 5.59.

It was noted from the results (Table 5.59) that during using modified workstationsMW1 and MW2, the discomfort rating in different parts of the workers was comparatively lower than using of existing one. It was also noted that among four prototype workstations the lowest value of BPD was found in shoulder and lower back in case of working with the workstation height of 70 cm (MW2). The overall body part discomfort rating showed the lowest value for working in the workstation with70 cm height. However, the results of statistical analysis (ANOVA) showed that there was no significant difference in mean body part discomfort of the workers during performing the task with four workstations. Though, a propensity of lessening of BPD rating was obtained in case of MW1 and MW2 prototype workstations, as mentioned earlier. Hence, it might be stated that the modified workstation having height of 70cm was comparatively more comfortable for the users than that of existing one.

5.7.5.3. Evaluation by body joint angles:

Body posture of the carpenters was found to be changed with the change of height of the workstation. It was measured by the change of angle of different body joints. Firstly, during normal erect condition, different angles of body joints of the workers was measured and considered as reference. During using modified workstations different joint angles of the body viz., shoulder, elbow, wrist and hip were measured and those were compared with that of the using the existing one. The deviations of body joint angles, during using existing and modified workstations, were computed. The results have been presented in Table 5.60.

From the findings of body joint angle it proved that the different angles of the body joints was changed from reference posture depending on workstation height. Results indicated that shoulder angles of the workers were increased from references posture for all heights of workstations including existing one indicating shoulder abduction during work. However, the abduction was the lowest in case of using the workstation height of 70.0 cm (MW2). Moreover, the deviation of angle from that of reference posture was also the lowest (Table 5.61). It was also noted that the deviation of elbow angle from that of the reference posture showed the lowest value in workers who were using the workstation (MW2) of 70cm. The wrist joint of the workers using MW2 (70cm) showed the lowest variation with respect to other two workstations with different heights. The hip joint angle was found to increase from that of reference posture indicating lesser degree of bending and the deviation of this angle was also the lowest in case of using MW3 workstation.

Table 5.60 :**Different body joint angles (Mean ±SD) of carpenters working in existing and modified workstation with different heights (n=24)**

Body Joint Angle		**normal erect posture**	**Body joint angles in workstations of different heights**			
			Existing working height	**Modified workstation height**		
			EW (60.3cm)	**MW1 (65cm)**	**MW2 (70cm)**	**MW3 (75cm)**
Shoulder	**R**	37.49±5.39	61.03±10.54	58.6±5.91	51.42±6.56	60.48±8.00
	L	35.92±5.23	79.45±8.03	71.90±10.80	63.26±8.11	74.10±9.84
Elbow	**R**	163.48±7.12	130.03±15.83	151.97±18.07	159.46±7.39	168.71±9.37
	L	164.98±8.17	124.87±13.42	153.77±6.87	160.32±8.37	170.03±9.73
Wrist	**R**	174.94±4.89	155.84±21.02	167.90±13.16	169.84±5.20	180.23±8.40
	L	175.57±5.33	150.87±20.93	168.97±13.53	170.32±7.90	180.26±10.47
Hip	**R**	174.02±4.67	140.92±10.52	144.87±8.60	162.71±8.80	166.32±14.87
	L	172.94±6.26	147.52±8.53	150.53±10.45	165.19±8.16	167.61±14.53

Table 5.61: **Deviation of different body joint angles of carpenters working in workstation with different height from normal erect posture(n=24)**

Body Joint angle		Deviation from normal erect posture			
		Existing working height	Modified workstation height		
		EW (60.3cm)	MW1 (65cm)	MW2 (70cm)	MW3 (75cm)
Shoulder	**R**	23.54	21.11	13.93	22.99
	L	43.53	35.98	27.34	38.18
Elbow	**R**	33.45	11.51	4.02	5.23
	L	40.11	11.21	4.66	5.05
Wrist	**R**	19.1	7.04	5.1	5.29
	L	24.7	6.6	5.25	4.69
Hip	**R**	33.1	29.15	11.31	7.7
	L	25.42	22.41	7.75	5.33

Therefore, from the results of joint angle study it may be stated that the workstation MW2 (70cm) was less stressful as most of the joint angles of the workers were deviated less from the reference joint angles. So, it might be pointed out that using modified workstation with a height of 70 cm, the users had less biomechanical stress.

5.7.5.4. Study of EMG voltage:

The EMG study of the shoulder (Trapezius) and back (Lattisimus dorsi) muscles of the carpenters was conducted while working with four prototype workstations of different heights on a comparative basis. The EMG voltages of the aforesaid muscles were also recorded in normal standing posture (without work), which was considered as reference posture of the workers. The deviations of EMG voltages recorded under working postures from that of the reference posture were calculated. The results of the ANOVA demonstrated that there was a significant difference in EMG-RMS values of shoulder muscles ($p<0.001$) of the carpenters during using workstations of different heights (Table 5.62).

Table 5.62 : Mean and SD of EMG-RMS values (µV) of shoulder muscle of carpenters (plane users) working in existing and three modified workstations of different heights(n=10)

R= right side L= left side

Different workstation height	EMG-RMS-R		EMG-RMS-L	
	Value (µV)	Deviation from normal standing	Value (µV)	Deviation from normal standing
Normal standing (resting)	10.2±2.16	-	9.8±3.4	-
Existing working height (60.3cm)	227.72±9.81	217.52	234.18±7.13	224.38
MW1 (65cm)	219.43±10.7	209.23	210.47±6.39	200.67
MW2 (70cm)	185.36±4.16	175.16	196.51±4.7	186.71
MW3 (75cm)	241.68±6.24	231.48	237.58±5.94	227.78
F-value	85.75*		103.18*	

$^{*}p<0.001$

During work the activity of the muscles was increased that caused an increased voltage of EMG in shoulder muscle. However, RMS values of EMG voltages were found to be reduced progressively with the increase of the work surface height (Table 5.62) except for the using the workstation MW2 where the EMG value was the lowest between modified work stations. Moreover, the deviation of EMG-RMS values of the right and left shoulders from that of reference values (normal resting) were the lowest in modified workstation MW2. The findings revealed that there was the least shoulder muscle stress during working with the modified workstation MW2. Widanarko et al.(2015) reported that working height was one of the factors for shoulder muscle strain. They also reported that tool-driven work of the spinner handcuff muscles, superior part of the trapezius and frontal deltoid muscle were spanned with increasing height. Wallius et al.(2016) established the fact by EMG study that the upper range of optimum height of holding area can reduce the shoulder muscle activity.

Table 5.63 :Mean and SD of EMG-RMS values (μV) of back muscle of carpenters (plane users) working in existing and three modified workstations with different heights(n=10)

[R=right side L=left side]

Workstation with different heights	RMS-R		RMS-L	
	Value (μV)	**Deviation from normal standing**	**Value** (μV)	**Deviation from normal standing**
Normal sitting (resting)	10.46±1.71	-	11.42±2.14	-
Existing working height (60.3cm)	204.41±7.73	193.95	200.16±8.46	188.74
MW1 (65cm)	202.13±11.14	191.67	196.74±10.17	185.32
MW2 (70cm)	186.43±6.88	175.97	170.39±7.46	158.97
MW3 (75cm)	209.45±8.22	198.99	211.28±9.41	199.86
F-value	13.20*		37.58*	

*p<0.001

The results of the study of EMG of back muscle have been presented in Table 5.63 and it was revealed that values of EMG-RMS of the back muscle of both sides were significantly different (p<0.001) while working with workstations with different heights. In general it was noted that the EMG voltages were increased during working condition in respect to reference condition. From the findings of joint angle study, it was stated that during working condition worker had to bend forward (shown in terms of hip angle) which might increase the myoelectric activities of the back muscles in compare with the reference condition. While comparing EMG signals among four prototype workstations during working, the results showed that RMS values of back muscle of both side was the lowest in case of working with workstation height of 70cm. It was also observed that the deviations of EMG-RMS values of the back muscle from that of reference posture was also the lowest in case of working with the modified workstation MW2 among all workstations.

From the EMG studies of shoulder and back muscle, it seemed that the electrical activities were found to be lowest in both of these muscles during working on the workstation having the height of 70cm. Thus the results proved that the muscle stress was lesser in the said work station in comparison to other workstations. Therefore, a workstation having height of 70cm might be appropriate for the plane user. Pejčić et al., (2016) reported that during the stronger activity of muscle generated stronger wave length in EMG recording. According to the report of Herrington et al., 2016 supporting base of the hand muscle and load applied in the muscle were two important factors for different considerable stress on scapula and shoulder muscle.

5.7.5.5. Productivity Study:

While the workers performed their planning task in existing as well as in different modified workstations the productivity study was conducted. The area (sq.cm) of wood they shaped with the plane in a given time was measured and it was expressed in unit time which was referred as the productivity. Productivity was notably increased in case of working in the modified workstations (MW2) (Fig 5.13). Among the modified workstations, the workstation having the height of 70 cm represented the highest score ($p<0.01$). The results showed that there was an increase in productivity by about 10.31% in the workstation of 65 cm and by about 21.72% in the workstation of 70cm.

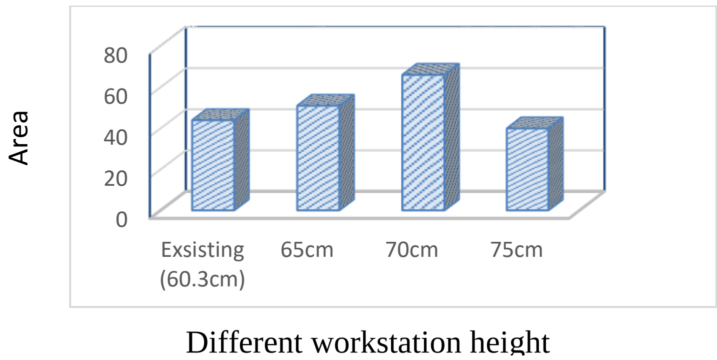

Fig 5.13: Mean productivity (area of wood plaining in sq.cm/min) with existing and modified workstation

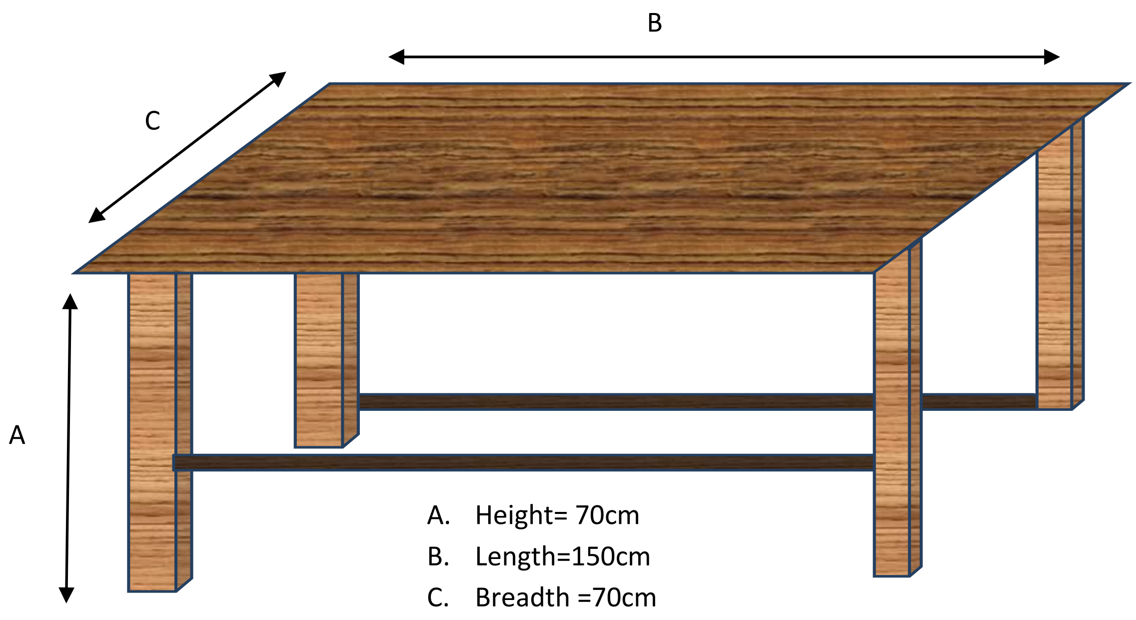

Fig 5.14: optimized dimension of the workstation

Thus, from the view point of productivity it can be stated that the modified workstation having height of 70 cm was better than that of existing workstation.

5.7.6. Optimization of Workstation:

From the results of the above studies it might be abridged that the modified workstation having the height of 70 cm was the best for the users and also comfortable for them. The height of the working platform was settled by the anthropometric dimension and the subjective preference of the users. The work surface height is usually determined according to the elbow height of the users, which is taken as the reference height for standing work. The 5th percentile value of the elbow height of the users was 75.7 cm. Generally, it was recommended that the working height should be slightly below the reference height (elbow height) in case of performing heavy work. Wood planning was a heavy work in carpenter's workshop. Therefore, a reduction of 5.0 cm from the computed elbow height might be done and the estimated height became (75.7 cm – 5.0 cm) ,i.e., 70.7 cm. From the results of the paired comparison test it was revealed that the best preferred workstation height of the users was70.0 cm. considering these two facts together the optimum height of the workstation was fixed as 70.0 cm. The results of the other studies also supported this optimization. The body part discomfort rating showed lesser extent of pain / discomfort in the suggested workstation. The joint angle studies indicated lesser biomechanical stress on the body of the carpenters while working in the suggested workstation. The myoelectric activities of shoulder and back muscles were comparatively lower during executing panning work in the modified workstation. The productivity was also in favor of modified workstation. Therefore, the workstation having height of 70cm was suggested as optimum.

Although the height of the workstation is of prime importance regarding comfort of the worker yet the length of the workstation can be evaluated. The length of the workstation could be determined according to the forward arm reach (functional) of the worker. The 95th percentile value of the functional arm reach was 69.2 cm. This was the minimum requirement. However, space should be given movement of hand plane during shaping of wood. Therefore additional lengthwise space was required. Another 80cm might be added to the arm reach value (69.2+80=149.2) for the space for carpenters' plane and the piece of wood under work. The value was rounded off to 150.0 cm.

The breadth of the workstation was not changed from that of the conventional one. A breadth of 70.0 cm was sufficient for the work. The carpenters had no complaint about the breadth of the working platform. A diagrammatic presentation of the modified workstation has been shown in Fig.5.14.