DESIGN ANALYSIS TOOL SUPPORT RELEASE AND INSTALLATION PROCESS WHEELS TOYOTA INNOVA WITH ERGONOMICS METHODS

Surjo Hadi[1]

Kartini University Surabaya
INDONESIA
E-mail: bestsuryo@yahoo.com

ABSTRACT

The increase in vehicle sales is not complete if it is not supported by after-sales service. In use vehicle requires maintenance services that make the vehicle performance can be maintained. So the security, safety and comfort for the vehicle users more secure. Maintenance and repairs are conducted regularly to extend the life of the vehicle. Along with this, of course, after sales services provider (after sales service) provide the best car care service the greater spread in various places . The application of ergonomics in general is an activity design or redesign. This can include hardware such as working tool (benches), platforms, seats, handles work tools, control systems, props, street / hallway, doors, windows, etc. Still in the case is a discussion of the design work environment, because if the system hardware such as the work environment will change as well. It can be said that the development of the science of ergonomics begins when the human design simple equipment to assist its activities. Based on the results of analysis show that things are not working ergonomics. To Obtain conformance with its body segments then the design of the ergonomic work tools. The design is done by utilizing the data of existing anthropometric workers. The results showed that the Waiver Process Supporting Tools and Installation This wheel gives the average results of that tool after the design is more efficient than the prior design tool.

Keywords : Design Analysis, Tool Support, Ergonomics, Toyota, New Equipment Design

INTRODUCTION

Increased customer demands for four-wheeled vehicles, stimulates the automotive companies to increase production impact on increasing sales. For car manufacturers (Single Agent Brand) Increased vehicle sales is incomplete if it is not supported by after-sales service. In use vehicle requires maintenance services that make the vehicle performance can be maintained. So the security, safety and

comfort for the vehicle users more secure. Maintenance and repairs are conducted regularly to extend the life of the vehicle. Along with this, of course, after sales services provider (after sales service) provide the best car care service the greater spread in various places. When reviewing the activities of technicians in performing maintenance of a vehicle, the amount of time and effort is needed by technicians. This is because the number of components in a vehicle quite a lot. In addition, the dimensions and location of sesetiap different components, so that the work load given by each component of the body in different technicians. When the technician working inside a fairly heavy and not done in a proper way, then the effect of this work can affect the health of the body technician. And finally affect the productivity of the technician.

Fact the field indicates that the health of the body in motion to get the job done should be taken into account appropriately. It is intended that the work cycle is maintained and work productivity can be achieved, then the effect of this work can affect the health of the body technician. And finally affect the productivity of the technician. Problems gestures technicians in performing maintenance work vehicle that had been known to the author is just the paradigm of gestures in the process of maintenance technicians with a quick vehicle with a Brief time, so ignored aspects of safety and health technicians themselves so as to get the efficiency of the work and ensuring the work safety , the authors observed working with ergonomic approach that focuses on the interaction of human and workers, facilities (equipment), procedures, products and work environment.

MATERIALS AND METHODS

Company Profile

PT. Astra International, Tbk Toyota Sales Operation is a national private company that serves as a dealer vehicle Toyota brand, which was established on February 20, 1957 in Bandung and is managed and led by William Soeryadjaja, Tjian Kian Tie and Liem Peng Hong. In 1965, PT.Astra International, Tbk Toyota Sales Operation centralize its headquarters in Jakarta and Bandung office serve as the first branch. To facilitate the course of the distribution of the formed several branches, representatives and dealers in the appointment of the cities that are considered important. Along with the development of economy and development in Indonesia, which was marketing a wide range of products, one by one break away and develop into a new company that has branches in various cities. On July 1, 1969, PT. Astra International, Tbk Toyota Sales Operation received official recognition from the Government of Indonesia as a single agent for the Toyota brand motor vehicles throughout Indonesia. In 1970, PT. Astra International, Tbk Toyota Division Toyota Sales Operation form that focuses on the distribution and marketing of Toyota brand vehicles. In accordance with the marketing development of the Toyota brand vehicles are getting better then on January 1, 1976 was established PT. Astra Motor Sales acting as one of the main distributor of Toyota brand vehicles. On 1 September 1989 by PT. Astra Motor Sales again

renamed AUTO 2000 PT. Astra International, Tbk Toyota Sales Operation. Then, starting on January 1, 2000 AUTO 2000 changed the name, so the name of the company became PT. InternationalTbk Astra, Toyota Sales Operation AUTO 2000 the company headquarters located in Jakarta and currently has branches and dealers spread across major cities in Indonesia. One branch of the company is PT. Astra International.

Application of Ergonomics

The application of ergonomics in general is an activity design or redesign. This can include hardware such as working tool (benches), platforms, seats, handles work tools, control systems, props, street / hallway, doors, windows, etc. Still in the case is a discussion of the design work environment, because if the system hardware in the form it will change the work environment as well. It can be said that the development of the science of ergonomics begins when the human design simple equipment to assist its activities. The incident was seen ranging from the use of simple objects such as stones to help a hand in doing the job, to do repairs or changes to the aids to facilitate its use.

a. There are several factors that will affect the size of the human body, so it should a product designer must consider those factors which include:
   Age. In general, the dimensions of the human body will grow and increase in size - with age - ie since the beginning of his birth until the age of around 20 years. From a study conducted by Roche and Davila (2009) in the USA it is concluded that the male will grow and develop up until the age of 21.2 years, while women 17.3 years, although there are about 10% which is still rising high until the age of 23.5 years (men) and 21.1 years (women). After that, no longer will occur even growth will actually tend to turn into a decrease or shrinkage that begins around the age of 40 years.

b. Gender (sex). Dimensions of male body size will generally bigger than women, except for a few specific body parts such as the hips, and so on.
c. Tribes / nations (ethnic). Every tribe, nation or ethnic group will have physical characteristics that would be different from one another. Figure 1 below shows the difference in the dimensions of size (height) of the various ethnic groups (5-th and 95-th percentiles) specific.

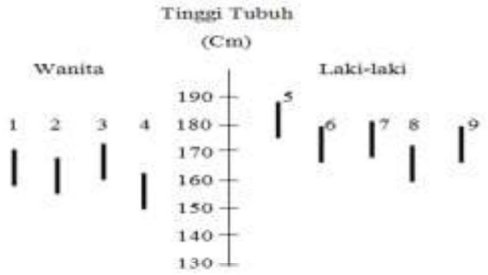

Figure 1 Height Differences in the Human Body
Upright standing position for Different Ethnic Groups
Note: 1. United 5. America (pilot) 9.Turki (military)

Note : 1. Amerika 5. Amerika (pilot) 9.Turki(militer)
2. Inggris 6.Italia(militer)
3. Swedia 7. Prancis (militer)
4. Jepang 8. Jepang (militer)

from individual measurements, as found for the product is made to order (job order). The situation becomes changed as more standard products that must be made to be operated by many people. The problems that arise here are size who can be chosen as a reference to represent the population. Given the size of the individual will vary from one another it is necessary to the determination of anthropometric data corresponding to the target population of these products. Issues that will arise in the determination of anthropometric data will lie in our ability to answer questions like the following:

a. How big is the sample measurements we take for the determination of the anthropometric data?.
b. Should any limited samples per group (segmentation) are homogeneous.
c. Is it available anthropometric data for specific populations that would later become the target user.
d. How can we tolerate differences that might be found from the data available to the population to be faced?.

For the determination of anthropometric data, the user will generally apply the normal distribution. In statistics, a normal distribution can be formulated based on the average price (mean,) and standard deviation (standard deviation, (x) from existing data. From the existing value, then the "percentiles" can be set according to the normal distribution probability table .By percentil, it is meant here is a value that indicates a certain percentage of people that have a size of at or below that value. For example, 95-th percentile will show 95% of the population will be at or below that size, while the 5-th percentile will show 5% of the population will be at or below that size. in anthropometry, 95-th digit will describe human size "largest" and the 5-th percentile instead will show the size of the "smallest". Whenever that is able to accommodate the expected size of 95% of the existing population, then here are taken range 2.5-th and 97.5-th percentil as its limits, as shown in the figure below

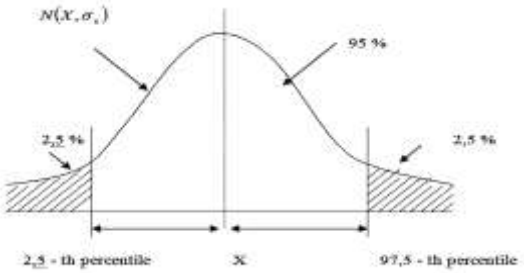

Figure 2
Normal distribution with the 95 th percentile anthropometric data

Assessment percentile values are generally applied in the calculation of anthropometric data can be described in Table 2.1 as follows:

Table 1 Wide percentile and the calculation method in the normal distribution

Percentile	Perhitungan
1 - St	$\overline{X}$ - 2.325 σ x
2.5 - th	$\overline{X}$ - 1.96 σ x
5 - th	$\overline{X}$ - 1.645 σ x
10 - th	$\overline{X}$ - 1.28 σ x
50 - th	$\overline{X}$
90 - th	$\overline{X}$ + 1.28 σ x
95 - th	$\overline{X}$ + 1.645 σ x
97.5 - th	$\overline{X}$ + 1.96 σ x
99 - th	$\overline{X}$ + 2.325 σ x

Source : Suma'mur (antropometry by Suma'mur's tailor method) (Suma'mur, 1989)

Application of anthropometry in the design of products

Anthropometric data serving size data of various kinds of human body parts in a certain percentile will be very beneficial at the time a product or facility design work will be made. In order to design a product will be in accordance with the size of the human body should operate, then the principles of what should be taken in the application of anthropometric data must be defined in advance as follows:

a. Product design principles for individuals with extreme size.
b. The principle of designing products that can be operated between certain size range.
c. Principles of design products with an average size

In connection with the application of anthropometric data required in the process of designing a product or working facilities, then there are a couple of suggestions / recommendations can be given according to the following steps:

a. The first time must first be assigned a member of the body that will be enabled to operate the design.
   Determine the dimensions of the body are important in the design process, in this case also needs to be considered whether it should use the structural data of body dimension or dimension of functional body.
b. Next specify the largest populations are to be anticipated, accommodated and the main target users of the product design. This is commonly known as "market segmentation", such as toys for children, household appliances for women, and others.
c. Set the size of the principles to be followed such as whether the design of the individual to extreme size, flexible size range (adjustable) or average size.
d. Select the percentage of the population that must be followed, 90-th, 95-th, 99-th percentile value or another desired.
e. For each dimension of the body that has been identified then select / assign the value of the size of the corresponding anthropometric data tables. Application data and add the leeway factor (allowance) when needed as well as additional factors due to the size of thick clothing to be worn by the operator, the use of gloves (glowes), etc.

Furthermore, to clarify the anthropometric data for design can be applied in a variety of products or work facility according Nurmianto (2003) in his book, then on the picture below will give you information about the various members of the body that need to be measured in Figure 3 below

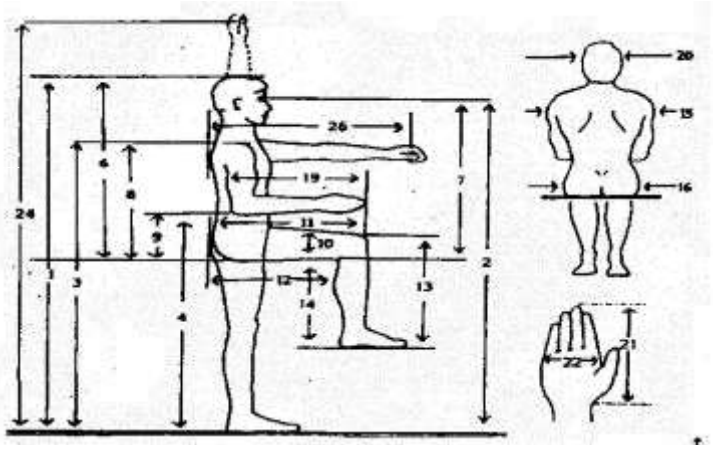

Figure 3
Measured anthropometric dimensions of the human body (Source of data: Wignjosoebroto, 2003)

Specification:
1. High body in an upright position eyes in the upright position.
2. High shoulders upright.

3. High angled in an upright position (elbows perpendicular)
4. High outstretched fist off the upright position (not shown in picture).
5. Height of the body in a sitting position (measured from seat cover / butt up to the head).
6. High eye in a sitting position.
7. shoulder height in a sitting position ..
8. High elbow in a seated position (elbows perpendicular)
9. Thickness or width of the thigh.
10. Thigh length is measured from the butt until tip of the knee.
11. Thigh length is measured from the butt until the back of the knee / calf.
12. High knee can be measured either in a standing or sitting position.
13. High body in a sitting position as measured from the floor up to the thigh.
14. Width of the shoulder (can be measured in a standing or sitting position)
15. Wide hips / buttocks
16. width of the chest in a swollen state (does not appear within the image shown).
17. Width stomach
18. Belbow length measured from the elbow to the tip of the fingers in the position of the elbow perpendicular.
19. Width of head.
20. Measured hand length from wrist to fingertips.
21. Width of the palm of the hand.
22. Width hand in hand position laterally stretched out wide left-right (not shown in picture).
23. High range hand in an upright position, measured from the floor up with an affordable hands straight up (vertical).
24. High range hand in an upright sitting position, measured as does No. 24, but in a sitting position (not shown in picture).
25. Distance range outstretched arms measured forward from the shoulder to the fingertips.

Anthropometric data were made according to the body size of the male and female, average price (), standard deviation (x) as well as certain percentil (5-th, 95-th, and so on).

New Equipment Design

Based on the results of analysis show that things are not working ergonomics. To Obtain conformance with its body segments then the design of the ergonomic work tools. The design is done by utilizing the data of existing anthropometric workers. The steps in the ergonomic design is as follows:

a. Determining the type of work facilities will be designed.
b. Determining percentile anthropometric data were used. It is aimed at designing for small and large sizes.

c. Determining the dimensions of looseness in the calculation results obtained.
d. Design work is more geared tool paddy thresher.
e. Workplaces designed for the expected user population by applying the relevant anthropometric data.

RESULTS AND DISCUSSION

On system performance of existing employees at this company, have different capabilities so that it takes the stage and the way that the way this employee's performance will not differ difference in doing a job.

Here the process of working on the after sales division as follows:

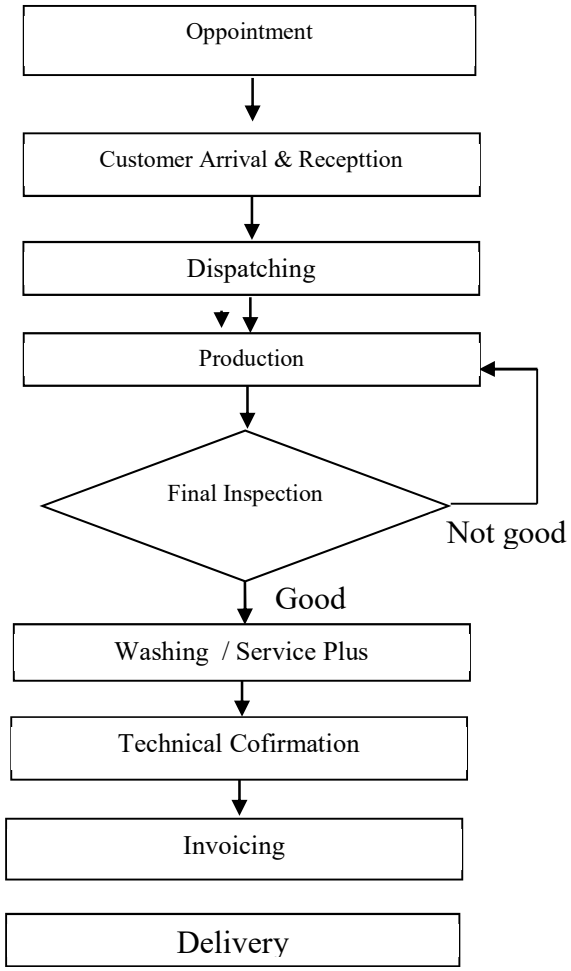

Figure 4 Work Process After Sales Division

Specification:

1. Appointment: The process of agreement to perform a service, this is often referred to by booking this section.
2. Customer Arrival Reception: In this section, the customer brought the car to be received by the admissions officer with the car parked in the parking area of service provided. Once the car was parked, then the officer gives that distinguished the queue number and queue nonbooking queue booking. Once given a queue number, and customers are welcome to wait in the waiting room reception service. Customers WHO are called queue number by service advisors (SA), and then will be served by the SA to perform the diagnosis to the vehicle, noting the condition of the car and asked about the other complaints. Furthermore, the SA will create a work order, and estimate the cost and time of execution services as well as inform the waiting room facilities to customers.Dispatching: The process of division of labor workshop. After the service advisors make orders CLA, the CLA

will be in place on the Job Progress Control Board for distribution to the mechanic through PTM officer

3. Production: Next car will enter the location of the garage to be serviced by a qualified service instructions set by Toyota. While customers are waiting for finished vehicles serviced are welcome to wait in the waiting room that has supplied The process of service is a major work of the workshop.Final Inspection: After the car was repaired by a mechanic, then Head of Team (foreman) re-checking the vehicle before being handed over to the customer
4. Washing or Service Plus: The process of washing a vehicle customers to increase customer satisfaction with the service workshop
5. Technical Confirmation: confirmation of the closure of PKB (Work Order Workshop), performed when the vehicle has been completed and ready to take customer
6. Invoiching: administrative process that includes, manufacturing of receipts, tax invoices, etc. to process the payment.
7. Delivery: Once the car is declared finished and clean, then SA (Service Dvisor) will notify the customer that the vehicle has been completed serviced. Furthermore, SA (Service Dvisor) will explain the condition of the car and repair what has been done and explained the costs to be paid. Once a customer makes a payment at the cashier, then SA (Service Dvisor) vehicles handed over to customers.

Test Data Sufficiency

Following the test the adequacy of the data standing elbow height when technicians work may be seen in Table 5 below:

Table 2 Adequacy Test Height

Data TB			$\sum Xi$	$\sum (Xi)^2$	$\sum Xi^2$
105,19	100,78	106,45	1846,87	3410917	189616,7
105,82	101,41	105,19			
98,89	102,67	100,15			
97,63	103,30	100,78			
102,67	99,52	105,19			
103,93	101,41	105,82			

Level of confidence: 95%, k = 2
The level of accuracy: 5%, then s = 0.05

$$N' = \left\lceil \frac{k / s\sqrt{N(\Sigma Xi^2) - (\Sigma Xi)^2}}{\Sigma Xi} \right\rceil^2$$

Conclusion:

Enough data, Due N' < N

$$= \left\lceil \frac{2 / 0.05\sqrt{18(3409117\ ) - (1846\ ,87)^2}}{1846,87} \right\rceil^2 = 1,012$$

Biomechanics

Following the processing and analysis of the biomechanics of the work process after the design tool.

Table 3 Data measurement body segments technician

No	TB (cm)	BB (kg)	Working angle (º)			load (kg)
			LB	LA	PG	
1	167	55	90	72	90	19
2	168	60	90	72	90	19
3	157	48	90	68	90	19
4	155	49	90	67	90	19
5	163	50	90	69	90	19
6	165	52	90	70	90	19
7	160	49	90	69	90	19
8	161	48	90	69	90	19
9	163	51	90	71	90	19
10	164	53	90	70	90	19
11	158	49	90	68	90	19
12	161	50	90	70	90	19
13	169	52	90	73	90	19
14	167	50	90	71	90	19
15	159	48	90	70	90	19
16	160	49	90	69	90	19
17	167	54	90	72	90	19
18	168	54	90	72	90	19

Analysis of the forearm segment technicians shown in the figure 9 below

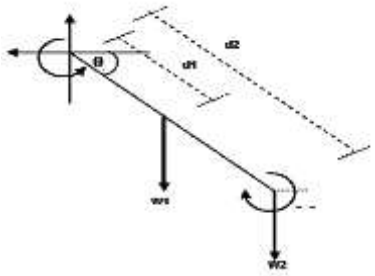

Figure 9 Components of the force on the forearm

W = m body weight. g. cosΘ = 55 x 10 x cos 0o = 550 N
W1 = 2.3% x W weight = 2.3% x 550 = 12.65 N
W2 = m load. g. cosΘ = 19 x 10 x cos 90o = 0 N

a. Analysis of style:

$\Sigma F = 0$

$F - W_1 - W_2 = 0$

$F_{LB} = W_1 + W_2$

$= 12{,}65 + 0$

$= 12{,}65$ N

b. Moment analysis

$\Sigma M = 0$

$M - W_1 \times d_1 \times \text{Cos } \theta - W_2 \times d_2 \times \text{Cos } \theta = 0$

$M = W_1 \times d_1 \times \text{Cos } \theta + W_2 \times d_2 \times \text{Cos } \theta$

$M_{LB} = (12{,}65 \times 0{,}18 \times \cos 90^o) + (0 \times 0{,}44 \times \cos 90^o)$

= 0 N.m

As for the results of analysis of the style and forearm moment on each technician will be described in detail in the appendix. So in get the average force = 11.7 N and the average - average moment on the forearm is 0 Nm

A. Upper Arm Segment Analysis Technician visible figure 10 below

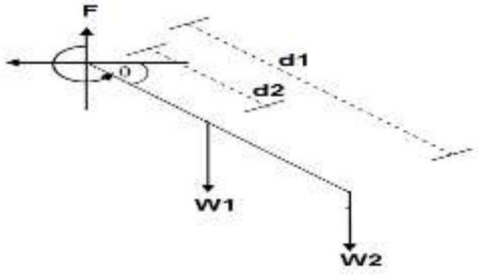

Figure 5 Graph heart rate measurements with oxygen consumption.

Interpolation Calculation: $\frac{(1.5-1)}{(x-1)} = \frac{(150-100)}{(113.33-100)}$

$$\frac{0.5}{x-1} = \frac{50}{13.33}$$

$$50x - 50 = 6.67$$

$$50x = 6.67 + 50$$

$$x = 1.13$$

So technically oxygen consumption after the work is 1.13 liters / min. If it is known that 1 liter of oxygen generates energy by 4.8 kcal of energy expended, the technician after the work is 1.13 x 4.8 = 5.44 kcal / min.
Subjectivity in the assessment authors use a survey of complaints technician after work using the tools of wheel removal and installation of Toyota Innova that has been designed according to the science of ergonomics. The results of the survey of the complaints listed in Table 9 technicians below:

Table 3 Complaints Survey Technician After Using Tools Already is designed

No.	complaint type	Rating	
		1	2
1	Pain in the left shoulder	3	15
2	Pain in right shoulder	4	14
3	Pain in upper left arm	2	16
4	Pain in the right upper arm	5	13
5	sore backs	3	15
6	Pain at waist	1	17
7	Pain in left elbow	1	17
8	Pain in right elbow	3	15
9	Pain in left forearm	4	14
10	Pain in right forearm	2	16
11	Pain in left wrist	3	15
12	Pain in right wrist	5	13
13	Pain in the left hand	4	14
14	Pain in right hand	3	15
TOTAL		43	209
%		17	83

* Note: 1 = Hospital, 2 = Not Sick

From the complaint survey data technician, showed a decrease in the number of complaints pain felt by the technician after using the tool to remove and install the wheel toyota innova.

CONCLUSION

Based on the processing and analysis has been described in the foregoing description, the results obtained in this study in accordance with the objectives of the research are as follows:

Table 4 Conclusion Results of Data Processing and Analysis

No.	Item	before	after
1	Style on the forearm (AND)	175,86	11,77
2	Moment of the forearm (N.m)	63,05	0
3	The force on the upper arm (N)	42,73	79,14
4	Moment on the upper arm (N.m)	1,74	6,95
5	Style on the back (N)	448,66	298,81
6	Moment on the back (N.m)	106,20	0
7	Energy consumption (kcal / min)	6,08	3,04
8	Average time standard (s)	52,30	41,70
9	Percentage of complaints of illness (%)	69,4	17

REFERENCES

Grandjean, E.(1986). Fitting the task to the man : An ergonomics approach. Philadelphia: tylor & Francis.

Hettingger, T.H. (2007). Angewandte Ergonomi. Bartman-Verlag, Frechen, BRD

Lehman, G. (2004). Practische Arbeitsphysiologi. 2. Auflage. Thieme Verlage. Stuttgart.

Lind, A.R. and McNicol, G.W, (1986). Cardiovascular responses to holding and carryin weight by hand and by shoulder harness.J.Applied Physiology, v.25,261-267

Muller, E.A. (1942). Die Puszahl als Kennzeichen fur stoffumtausch und Ermudbarkeit des
arbeitenden Muskles Arbeitphysiology 12, 92-106.

Nurmianto, E. (2008). Ergonomi, konsep dasar dan aplikasinya. Prima printing. Surabaya.

Stevensson, N.L. (2007). Lecture notes on the mechanics of human body. Faculty of Engineering, UNSW, sydney.

Sutalaksana, dkk. (2006). Teknik Perancangan sistem kerja. ITB. Bandung.

Wignjosoebroto, S. 2003. Ergonomi studi gerak dan waktu teknik analisisuntuk meningkatkat produktivitas kerja. Surabaya : PT. Guna Widya.

Winter, D.A. (1979). Biomechanics of human movement, Wiley