

PART 3 EVALUATION ON MAN-MACHINE SYSTEM

by

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3.1 Introduction

At the evaluation on the utility of the artificial hand, it is indispensably that is the analysis of the artificial and, for the man (amputee)-machine (artificial hand) system.

There are many reports on the evaluation of various artificial hands, but greater parts of them is the evaluation on the function of itself, or on the resemblance of the function between the hand of man and the artificial hand.

We have no secure method to evaluate the hand which have many function in the daily life. So it is too difficult to evaluate the practicality of the artificial hand for the daily life. In this paper, we attempted to evaluate the utility of WIME HAND from the data, consist of *basic chart*, *inspection chart* and *ADL chart*.

3.2 Evaluation principle

The utility evaluation of WIME HAND, in man-machine system, is based on three kind of data as follows.

3.2.1 Basic chart (Chart 3.1)

This is the case history of a amputee, and consist of past history, present condition.

At the same time when this chart is written, the schedule of the field testing with this amputee is made to watch all process.

3.2.2 Inspection chart

The aim of this chart is to make clear the mechanical characteristics of WIME HAND in its daily use, and to get bare

opinions to WIME HAND from amputee.

This chart is consist of five sections as follows,

- i) fitting
- ii) maintenance
- iii) function
- iv) experience
- v) keeping

This inspection was conducted from the first week of the field testing, according to the individual schedule. The specification of this chart is presented in chart 3.2.

3.2.3 ADL chart

The aim of this chart is to make clear the pattern characteristics of WIME HAND in its daily use. So, this chart must be written in the last period of field test, in anticipation of getting accustomed to use WIME HAND about an amputee.

Daily action using upper limb are quoted from the normal ADL chart, popularly used in rehabilitation medicine of JAPAN, and contains 102 heads, as follows,

- i) diet ----- 21 heads
- ii) cosmetics ----- 17 heads
- iii) dressing ----- 13 heads
- iv) communication ----- 9 heads
- v) other general action --- 42 heads

The specification of this chart is presented in chart 3.3.

3.3 Result

3.3.1 Inspection chart

Something wrong mechanically with WIME HAND, it was repaired immediately.

Many improvements were concentrated to the latest model of WIME HAND.

However, several problems were remained as follows,

- i) fitting
 - o bulky battery pack
 - o incomplete code length
 - o flexibility of code
- ii) maintenance
 - o troublesome in the travel
 - o weak grasping power
 - o slow speed of finger action

These were troubled at first time, but accustomed to use it was not insignificant as before.

- o takes long time to become inured to the change operation of pinching and grasping.

But it was few to use both function at same time in a week.

- o noise

This is most trouble some in every case.

- iv) experience
 - o heavy weight

As the weight of WIME HAND concentrated to the

distal end of arm, it was too heavy to use for long time. (But nobody stopped the test for this reason.)

o sweating

The amputees after sweat with thier stump during operating WIME HAND and sometime stopped the test.

It was caused by the peculiar Japanese climate, and very important fact for utility of artificial hand.

In this field testing, the amputees were limited as a rule to wright-worked male. So there were few change in their daily life with WIME HAND. Nevertheless, WIME HAND was used in wider fields as we expected, for example, farming, capentering, fishing, hand crafting, Kendo. In this field, WIME HAND is more effective than conventional prosthetic arms of hook type.

3.3.2 ADL chart

The results of ADL analysis was indicated as ratio R_1 and R_2 .

$$R_1 = \frac{b}{a} \quad , \quad R_2 = \frac{b+c}{a}$$

Where, "a" is a individual number of actions which the amputee has done usually in daily life with or without WIME-HAND, and "b" is a number of actions which were selected out of "a", never having done with WIME HAND, but not no useful and not efficient.

Data of R_1 and R_2 are indicated to the pentagon graph. Each axis of pentagon graph means one of ADL characteristics, as diet, cosmetics, dressing, communication and other general actions.

Twenty amputees were tested with ADL chart, and developed to three groups of pattern of pentagon graph. (see chart 3.4)

1) Group A (7 amputees)

This group indicates a wide spread typical pentagon shape by R_2 and R_1 is drawn a smaller concentric pattern.

2) Group B (6 amputees)

This group indicates a smaller irregular pentagon or square shape and " R_1 " and " R_2 " not indicate concentric pattern.

3) Group C (7 amputees)

This group indicates a very small irregular shape and indicates a single pattern of " R_1 " " R_2 ". The meaning of each results of three groups are as follows,

- * Group A is most suitable group for WIME HAND and expects to be necessary for them.
- * Group B is more suitable group for WIME HAND but they use WIME HAND selectively for effective work. Therefor it is necessary for this group to try evaluation using WIME HAND together with conventional pros-

thesis.

- * Group C is not troubled without WIME HAND, and should be reevaluated for the necessity of the artificial hand.

3.4 Summery

Data of man-machine system are surmmerized in chart 3.5. In this chart, "Decision" means results of evaluation about the necessity for WIME HAND to a individual amputee by a person in charge of Field testing belongs to each facility.

Therefore, results in this part included a personal views of each stuffs or facility, being inevitable to differ from results of over all end results.

Based on these data, we give a total result by four grading as follows,

- o 3 --- most suitable case for WIME HAND.
- o 2 --- more suitable case, but not so useful as 3 grade in daily life. If possible, being evaluated again about the adaptation of conventional prosthesis.
- o 1 --- If amputee's circumference require WIME HAND, it prefer to reinvestigate of utility for myoelect-ric hand and another conventional prosthesis.
- o 0 --- no adaptability for WIME HAND.

3.4.1 Conclusion

Taking the adaptable objects of WIME HAND as 2 and 3 grades of total results, fifteen in thirty subjects are suitable for WIME HAND. This result is much higher rate than the rate about the utility of conventional prosthesis in Japan.

For this reason, it is sure that WIME HAND has some superior functions in suitable amputees compared with another conventional prosthesis, nevertheless, WIME HAND can't take the place from conventional prosthesis but has sufficient utility as same as another artificial hand.

3.4.2 Prospective Views

In Japan, only a few amputees have been delivered the prosthesis under adequate evaluation and training, especially artificial hands.

On the one hand, the first prosthesis after amputation influence for amputee greatly. When WIME HAND being put on the market, we expect that the rehabilitation system of upper extremity amputee will be consolidated over all in Japan and amputees will be delivered WIME HAND under adequate evaluation and training. Concerning with WIME HAND themself, at first, evaluation of utility about wider objects like as house wife, heavy labor, must be tried. The enlargement of adaptability is no other than extension of necessity.

The second, improvement of machine are important with view to improve the acceptance for amputee, for instance, appearance and mechanical noise have some rooms for improvement.

The third, it is necessary to add the function of wrist. It is an obvious fact that the increase of freedom expand the utility of artificial hands.

Chart 3.1 Basic Chart

name _____ start date _____

 amputation R L bilateral
 stump length _____ cm/ _____ cm
 date of amputation _____
 cause of amputation _____
 stump condition _____
 remarks (amputation technique etc.) _____

history experience of prosthesis
 inexperienced
 experienced cosmetic hand
 functional hand
 work hand
 electric hand
 training trained
 not trained
 occupation before amputation _____
 after amputation _____

progress (machine NO. _____)	decision
<input type="radio"/> <input type="radio"/>	_____
<input type="radio"/> <input type="radio"/>	_____
<input type="radio"/> <input type="radio"/>	_____
<input type="radio"/> <input type="radio"/>	_____
<input type="radio"/> <input type="radio"/>	_____

final date _____

 sign of stuff _____

Chart 3.2 Wime Hand Inspection Chart

name _____

A) Fitting

1. How many hours
 - o all day
 - o _____ hr/day
2. Conventional prsthesis
 - o fitting
 - o somethime used
 - o no use
3. Buttery pack
 - o where ?
 - o case is ..
 - o regardless
 - o sometime disturbed
 - o disturbed
- any idea _____
4. putting on and off
 - o myself
 - o almost myself
 - o helped
 - o don't myself

B) Maintenance

5. gain control
 - o neglected
 - o sometime adjusted
 - o every day adjusted
6. Buttery capacity
 - o once cut out
 - o sometime cut out
 - o no trouble
7. cleaning
 - o every day
 - o sometime
 - o never

C) Function

8. glip power
 - o enough
 - o somewhat weak
 - o weaker
 - o too strong
9. pinching power
 - o accustomed
 - o something born
10. changing operation
 - o accustomed
 - o something difficult
 - o difficult
 - o impossible
11. Finger action
 - o too quick
 - o good
 - o slow
 - o slower
12. noise
 - o noisy
 - o sometime noisy
 - o noisy but regardless
 - o regardless
13. Finger opening
 - o good
 - o narrow
 - o wide
14. Operation of hand
 - o necessary to attend on purpose
 - o something necessary to attend
 - o sometime necessary to attend leg
 - o a situation
 - o easy, regardless

D) Experience

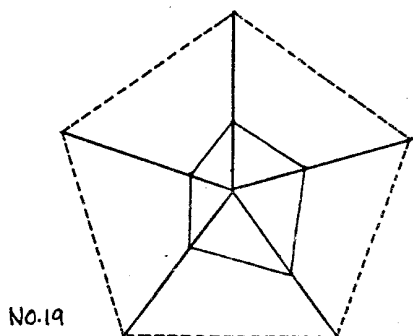
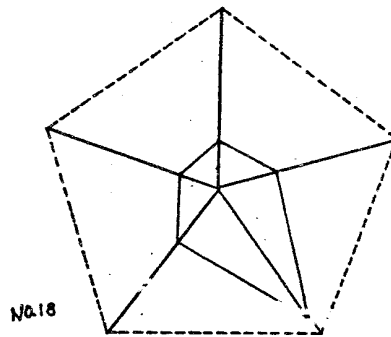
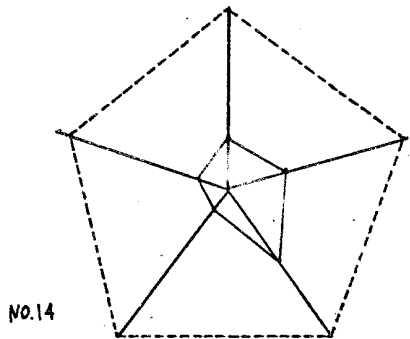
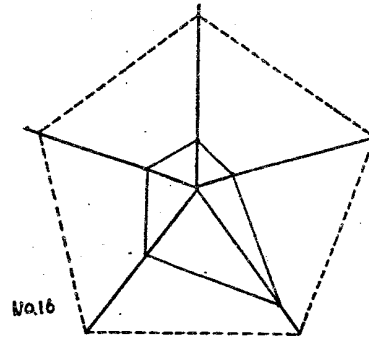
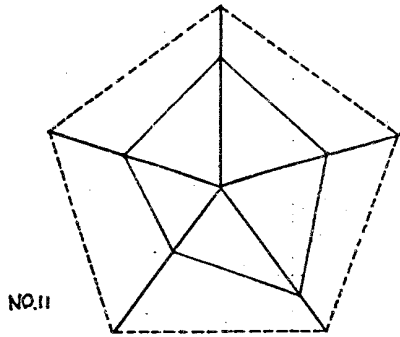
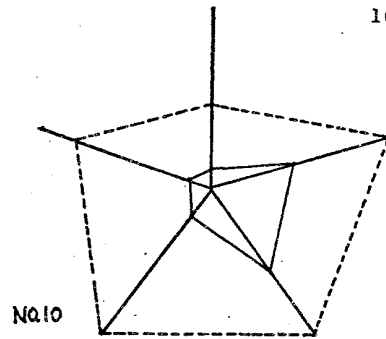
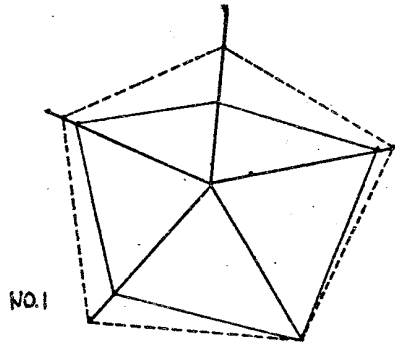
15. practicality
 - o accustomed
 - o something born
 - o being a burden
16. oppearance
 - o satisfaction
 - o bearable
 - o being a burden
17. color of hand
 - o good
 - o bad
 - o discolored
18. stump condition
 - o no disorder
 - o something wrong

findings _____

19. during operation not tired tired
20. weight good heavy light ill-balanced
- E) Keeping
21. care every day sometimes neglected
22. taking care myself leaving to others
23. glove condition no change soiled broken
 discolored
24. glove continued renewed
25. cable no change broken
when _____
26. amplifire no change broken down
when _____
27. socket fitted loosen tighten
- F) Remarks
- a feeling of satisfaction _____
- comment of stuff _____
- _____
- G) Date . . . frequency _____
- operator _____

Action				Action				Action				
	a	b	c		a	b	c		a	b	c	
Diet	using chopsticks				treatment of a cabinet				handling a window			
	using spoon				hanging a suit				drawing a curtain			
	using fork				buttoning				treatment of a wall socket			
	eating by finger pinch				treatment of Zipper				treatment of TV and radio			
	using fork and knife				putting on a trousers				using a key			
	bread and butter				Necktie				sweeping			
	eating bread by tearing				Zipper				cleaning with a vacuum cleaner			
	eating a fish cleanly				putting on trousers				Record			
	handling a nice bowl				tightening a belt				treatment of a wallet			
	using table salt				stocking				handling a slot machine			
	drinking with milk bottle after taking off the cap				putting on gloves				handling with a tweezers			
	drinking a canned juice				putting on hat				striking a match			
	cooking with knife				handling a safty pin				smoking with a lighter			
	peeling apple with knife				writing				turning on a gas			
	drinking with grass cup				making a letter				wearing a wrist watch			
taking a coffee				opening a letter				using an umbrella				
filling a cup with tea				Telephone				hammering				
cleaning table wears				public telephone (handling a coin)				sawing				
servng with tray				Interphone				sawing				
servng with wagon				Bicycle				handling electric tools				
handling a pot				Mortor cycle				handling a pliers				
turning a faucet				Mortor car				packing				
arrangement of fancy goods				reading book				painting with brush				
cleaning teeth				reading magazine				carring a bag				
combing				cutting with scissors				watering with a hose				
using hair dryer				ruling lines				watering from a bucket				
saving with razor				using an eraser				cultivation				
using electric shaver				holding a thick book								
cutting nails				using a knife (cutting paper)								
blowing a nose				filing documents								
drying with a towel				sealing (stump)								
using handkerchief				picking up a pin-ball								
putting on shoes				grasping a ping pong ball								
shoes polishing				grasping a base ball								
make-up				handking sliding door								
wring a towel				handling hinged door								
management of lovertory				pusssing a buzzer								
handling a toilet set												

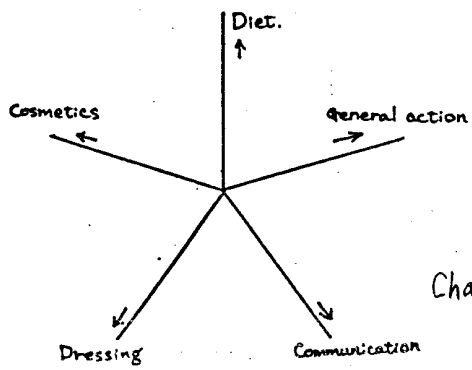
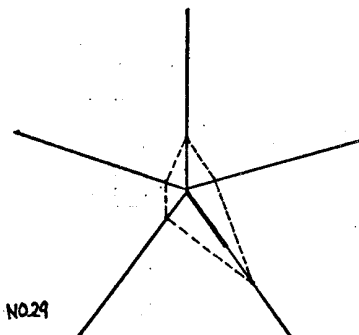
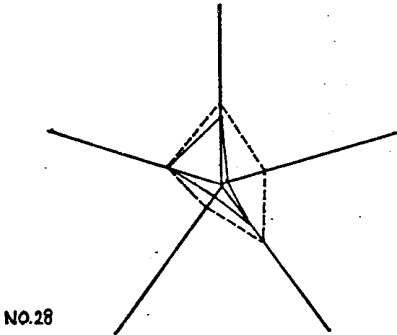
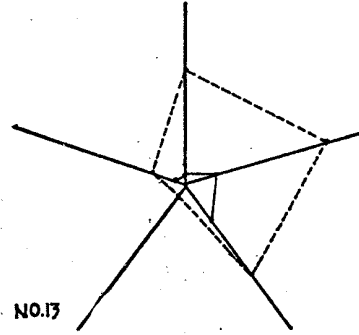
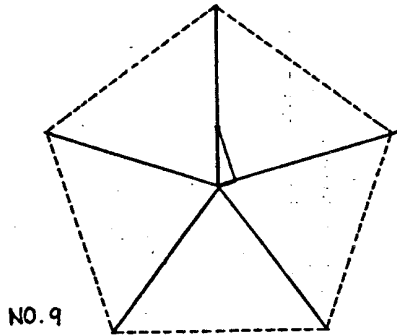
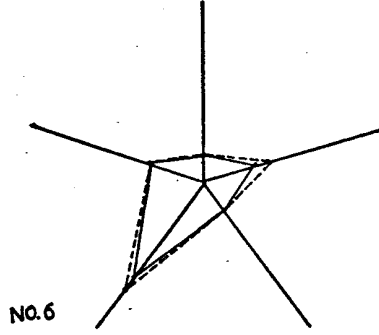
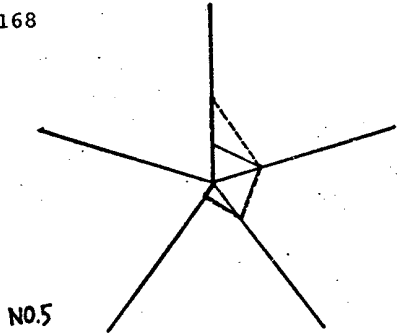
Chart 3.3 ADL Chart



----- $R_2: (\frac{b+c}{2})$
————— $R_1: (\frac{b}{2})$

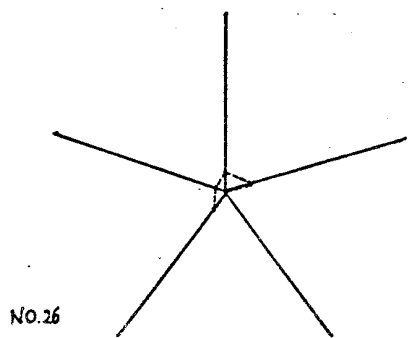
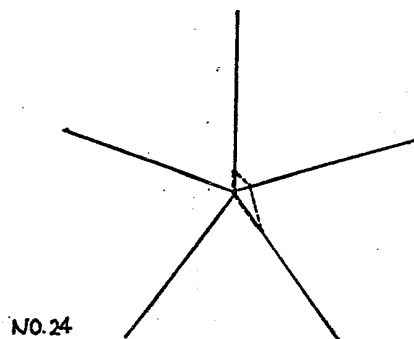
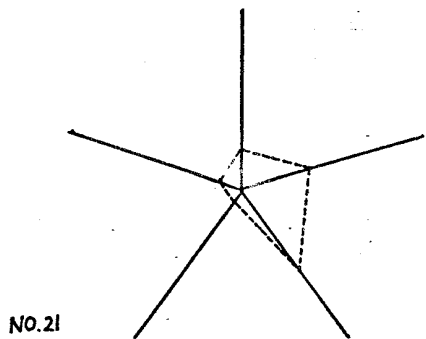
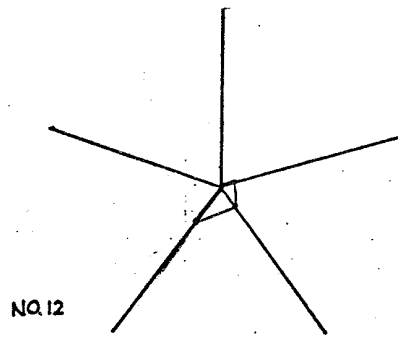
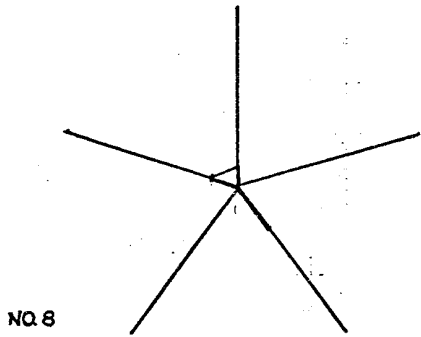
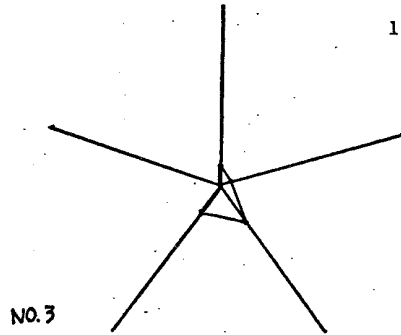
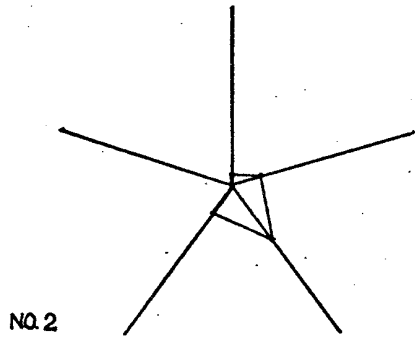
Chart 3-4(A) ADL ANALYSIS (GROUP A)

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----- $R_2: \left(\frac{b+c}{a}\right)$
 ———— $R_1: \left(\frac{b}{a}\right)$

Chart 3.4(B) ADL ANALYSIS (GROUP B)



----- $R_2(C \frac{b+c}{a})$
————— $R_1(C \frac{b}{a})$

Chart 3.4(c) ADL ANALYSIS (GROUP C)

NO.	age.	sex	side of amp.	occupation	experience of prosthesis	duration of WINE test	decision of stuff	remarks	problem	ADL analysis	conclusion
	Y.					years month	years month				
1	46	M	R L	office worker	experienced	1 . 2	unnecessary	bilateral		A	2
2	27	M	L	office worker and leather craft	experienced	. 5	difficult			C	1
3	26	M	L	warehouse keeper	inexperienced	2 . 1	necessary	motorbike only during working time		C	1
4	44	M	R	gate keeper	inexperienced	2 . 0	necessary			-	2
5	46	M	R	worker	experienced	1 . 6	difficult	not useful		B	1
6	45	M	R	gate keeper	inexperienced	1 . 5	necessary	during going out		B	1
7	61	M	R	feed seller	inexperienced	3	unnecessary		sweat	-	0
8	36	F	R	house wife	inexperienced	1 . 1	unnecessary			C	0
9	32	M	R L	worker	experienced	1 . 0	necessary	bilateral useful		B	1
10	29	M	R	printer	inexperienced	10	necessary	indispensable	shape noise	A	3
11	27	M	R	office worker	experienced	10	necessary	indispensable	durability	A	3
12	28	M	R	(out of work)	inexperienced	9	necessary	something better		C	1
13	25	M	R	salesman	inexperienced	6	necessary	indispensable	shape	B	2
14	30	M	R	office worker	experienced	1 . 11	necessary	high utility		A	3
15	34	M	L	business man	experienced	2 . 0	difficult		appearance noise	-	1
16	55	M	R	(out of work)	inexperienced	1 . 9	necessary	r-DB amputation high utility		A	3
17	21	M	R	worker	experienced	3m	unnecessary	not used		-	0
18	37	M	R	carpenter	inexperienced	1y . 5m	necessary	car driving		A	3
19	25	M	R	office worker	inexperienced	9	necessary	high utility	appearance	A	3
20	19	M	R	inspection of product	experienced	6	necessary	high utility		-	2
21	26	M	L	inspection of product	experienced	1 . 10	unnecessary	Independent by hook	weight	B	0

NO.	age.	sex	side of amp.	occupation	experience of prosthesis	duration of WINE test years month	decision of stuff	remarks	problem	ADL analysis	conclusion
22	28	M	R	mechanic	experienced	1 . 8	unnecessary	difficult to acceptance	weight sweating	-	0
23	26	M	R	manager of lumber dealer	experienced	--	difficult			-	0
24	27	M	R	salesman and farmer	experienced	1 . 6	necessary	useful for farming	sweating	C	2
25	47	M	R	designer	experienced	1 . 3	difficult	difficulty of fine action of finger-tips		-	0
26	45	M	L	teacher of high school	experienced	11	difficult	high utility	sweating	C	2
27	59	M	R	farmer	experienced	10	unnecessary	independent by hook		-	0
28	27	M	R	wiring worker	inexperienced	8	necessary	used together hook (immediate fitting)		B	2
29	44	M	R	confectioner	experienced	7	necessary	high utility	sweating	B	2
30	42	M	R	manager of lumber dealer	experienced	2 . 0	necessary	bilateral high utility		-	3

Chart 3.3. Conclusion of man-machine system