

2nd Day

11:15 - 12:00

VE APPLICATION TO PRODUCTION PROCESS IMPROVEMENT

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## 1. VE Approach to Production Process Improvement

As the scientific approach to production process improvement, QC and IE have been widely employed with great success.

However, the results of VE approach to production process are very few.

Accordingly the development in VE technique suitable to production process analysis, VE can be applied and realized the anticipated results, I believe.

## 2. Value in Production Process

Production process is composed by modules as shown in FIG. 2-1.

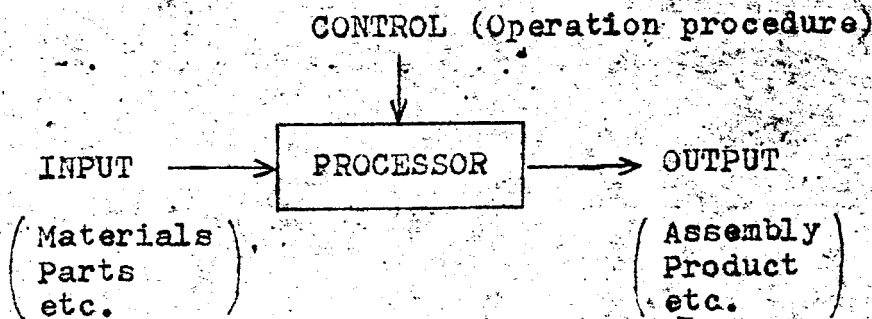


FIG. 2-1 Process Module

Value in process can be expressed by (2.1).

$$\text{Value} = \frac{\text{OUTPUT}}{\text{INPUT}} \dots\dots\dots(2.1)$$

OUTPUT/INPUT, which has function:

$$\frac{\text{OUTPUT}}{\text{INPUT}} = f(F_N, Q, C) \dots\dots\dots(2.2)$$

where,

$F_N$  is Number of Functions in process.

$Q$  is Quality in process.

$C$  is Cost in process.

Therefore, Value in process can be expressed by (2.3).

$$\text{Value} = f(F_N, Q, C) \dots\dots\dots(2.3)$$

Quality in process can be expected as yield, 1-P.

$$Q = 1 - P \dots\dots\dots(2.4)$$

where, P is defective rate in population of process.

$F_N(1-P)$  can be considered as the effectiveness of functions.

Consequently, Value in process can be defined in (2.5).

$$\text{Value} = \frac{F_N(1-P)}{C} \dots\dots\dots(2.5)$$

where,

$F_N$  is number of functions in process.

P is defective rate in process.

C is cost, which needs to add functions in process.

### 3. Value Analysis in Production Process

#### 3.1 Definition of Function

Function in process can be defined by "VERB + NOUN", same as VE in product.

Notice that:

(1) It must not use higher level expression in VERB part, the reason why all processes are fear to express in same VERB and it is difficult to make the functional family tree after mentioned.

(2) For example, in "Soldering process", definition "solder ~ to ~" is better than "connect ~ to ~". Definition like "connect ~ to ~" may become the object for the design change i.e. VE in design.

(3) This technique is expected that Foremen and QC circle members can use easily in their production process improvement.

#### 3.2 Functional Family Tree

It is convenience to make the functional family tree in production process by using the variation of Ather E. Madge's method, like FIG. 4-2.

### 3.3 Value Evaluation

Value in actual process  $V_A$  can be expressed by

$$V_A = \frac{F_N (1-P)}{C_A} \dots\dots\dots(3.1)$$

where,  $C_A$  is cost in actual process.

Value in standard process  $V_S$  can be expressed by

$$V_S = \frac{F_N}{C_S} \dots\dots\dots(3.2)$$

where,  $C_S$  is cost in standard process,

$P$  in standard process is zero.

As the degree of achievement of value in process, value ratio  $V_R$  can be given by

$$V_R = \frac{V_A}{V_S} \dots\dots\dots(3.3)$$

Smaller  $V_R$  has more margin in improvement.

Process with the smallest  $V_R$  means the critical path in function.

Process with  $V_R = 1$  means that has been improved as same as standard process.

Therefore improvement target can be set up as

$$V_R = 1 \text{ i.e. } V_A = V_S$$

Improvement activities are started in order smaller  $V_R$  that are achieved effectively.

#### 4. Case Study in TV Tuner Production Process

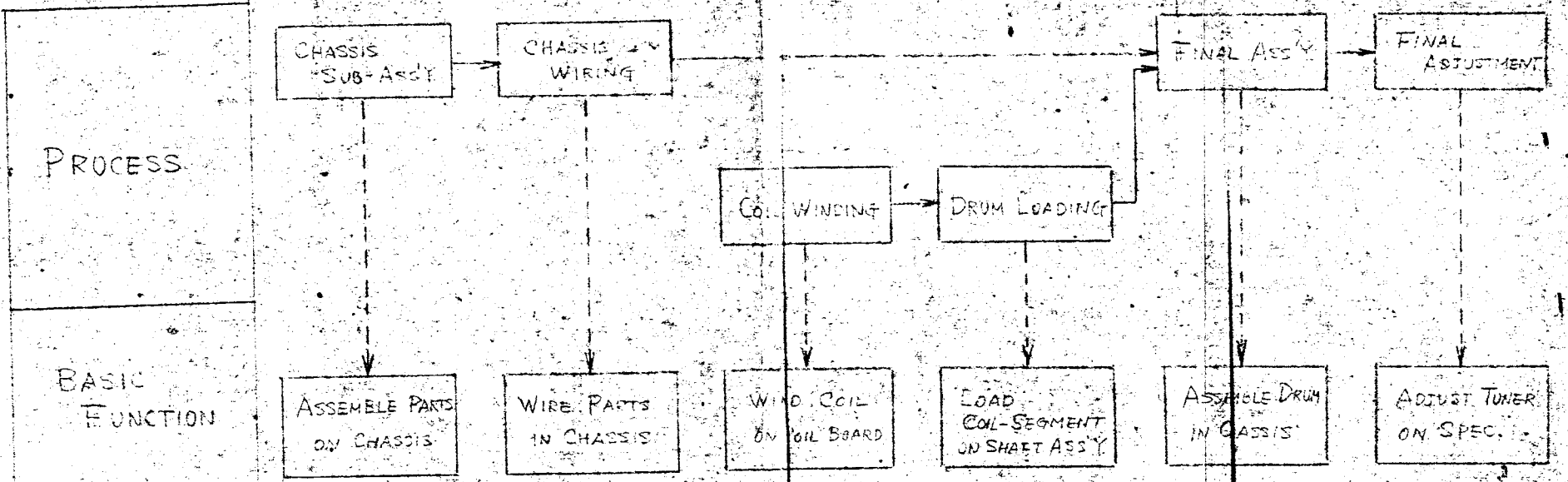
Outline of TV Tuner production process, its basic function and evaluation of value in each process are shown in FIG. 4-1.

In FIG. 4-1, "Chassis Sub-Ass'y Line" is set up as the object process to improve in value.

Functional Family Tree of "Chassis Sub-Ass'y Line" is shown in FIG. 4-2.

Value evaluation in the object process --Chassis Sub-Ass'y Line-- is shown in Table 4-1 as before improvement, and Table 4-2 as the result of after improvement.

FIG. 4-1. TV TUNER PRODUCTION PROCESS  
BASIC FUNCTION AND VALUE EVALUATION



| NUMBER OF FUNCTIONS $F_N$             | 55     | 60     | 66     | 25     | 10    | 38     |
|---------------------------------------|--------|--------|--------|--------|-------|--------|
| DEFECTIVE RATE $P$                    | 0.069  | 0.083  | 0.066  | 0.001  | 0.004 | 0.063  |
| YIELD RATE $1-P$                      | 0.931  | 0.917  | 0.934  | 0.999  | 0.996 | 0.937  |
| EFFECTIVENESS OF FUNCTIONS $F_N(1-P)$ | 51.205 | 55.020 | 61.472 | 24.975 | 9.960 | 35.606 |
| ACTUAL COST $CA$                      | 25.40  | 61.20  | 64     | 5.10   | 20    | 37.90  |
| STANDARD COST $CS$                    | 19.41  | 58.00  | 38     | 5.00   | 650   | 36.00  |
| ACTUAL VALUE $VA$                     | 2.016  | 0.899  | 610    | 4.897  | 679   | 0.939  |
| STANDARD VALUE $VS$                   | 2.834  | 1.034  | 826    | 5.000  | 626   | 1.056  |
| VALUE RATIO $VR$                      | 0.71   | 0.87   | 88     | 0.98   | 96    | 0.89   |
| STARTING ORDER                        | 1      | 2      | 3      | 6      | 5     | 4      |



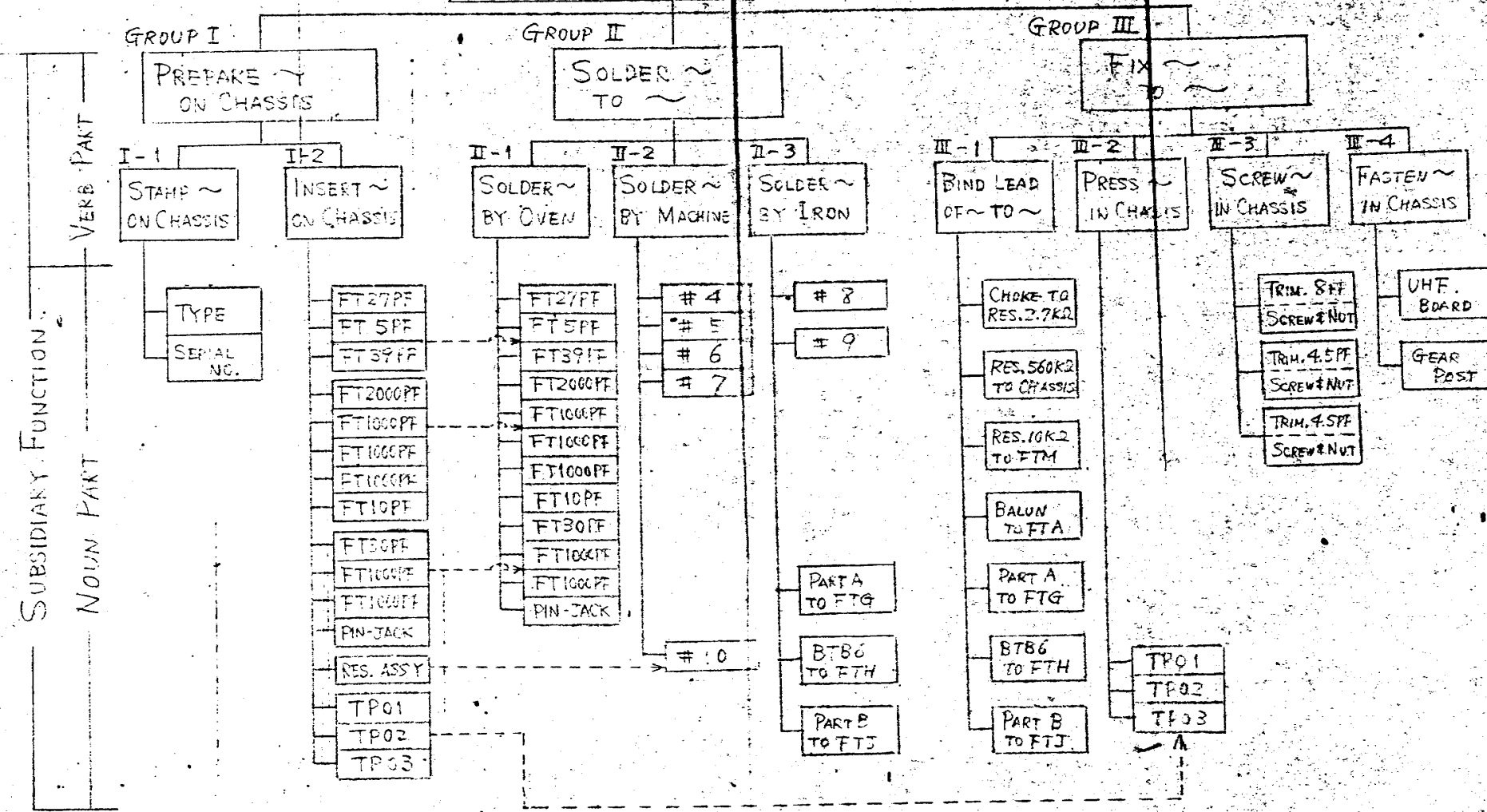
FIG. 4-2 FUNCTIONAL FAMILY TREE OF CHASSIS SUB-ASSY LINE

PROCESS

CHASSIS SUB-ASSY LINE

BASIC FUNCTION

ASSEMBLE PARTS CHASSIS



# VALUE EVALUATION IN CHASSIS, SUB-ASSY LINE

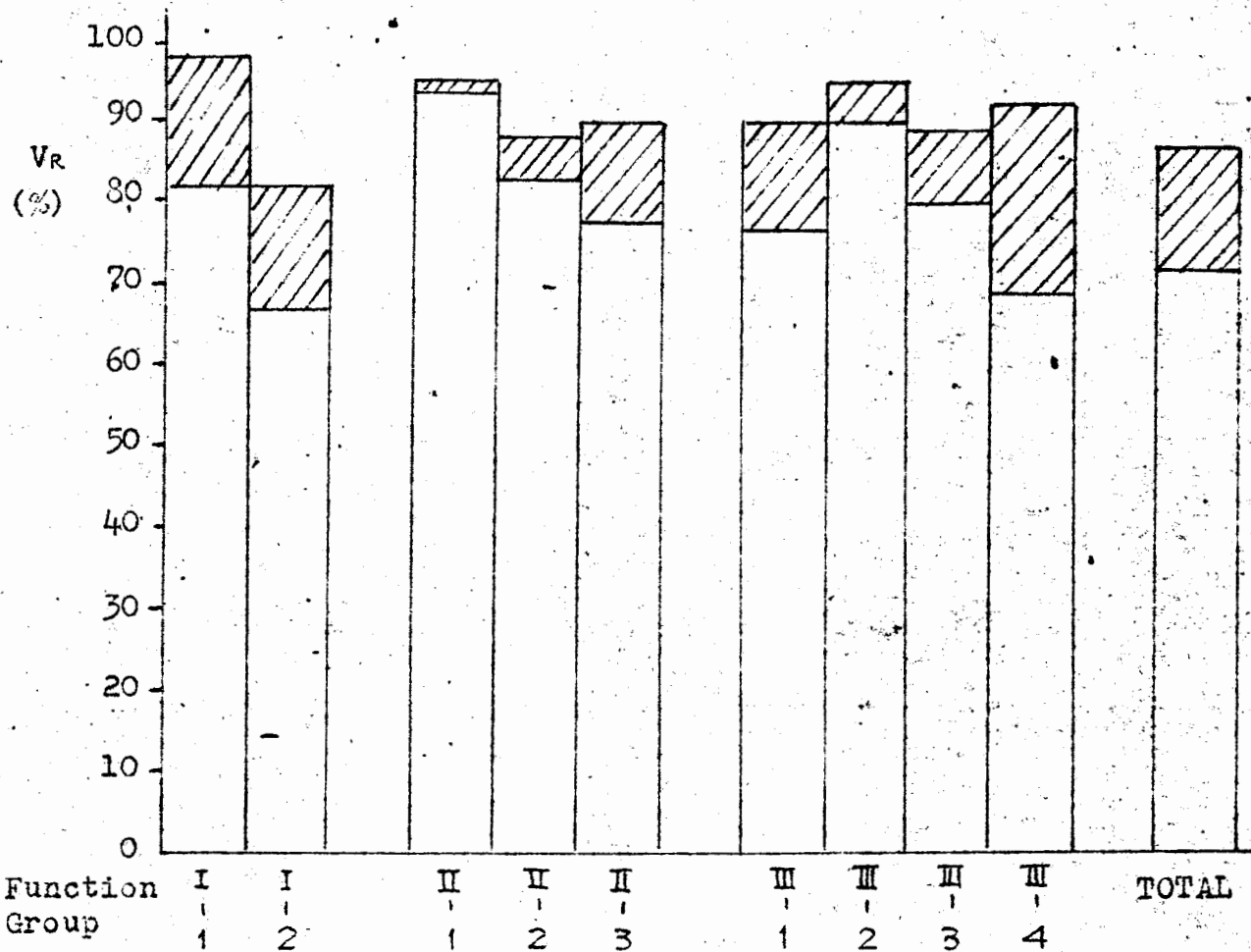
## TABLE 4-1 BEFORE IMPROVEMENT

| BASIC FUNCTION                     | ASSEMBLE PARTS ON CHASSIS |                        |                         |                       |                          |                       |                           |                          |                          |                           |       |
|------------------------------------|---------------------------|------------------------|-------------------------|-----------------------|--------------------------|-----------------------|---------------------------|--------------------------|--------------------------|---------------------------|-------|
|                                    | SUBSIDIARY FUNCTION       | PREPARE ~ ON CHASSIS   |                         | SOLDER ~ TO ~         |                          |                       | FIX ~ TO ~                |                          |                          |                           | TOTAL |
|                                    |                           | I-1 STAMP ~ ON CHASSIS | I-2 INSERT ~ ON CHASSIS | II-1 SOLDER ~ BY OVEN | II-2 SOLDER ~ BY MACHINE | II-3 SOLDER ~ BY IRON | III-1 BIND LEAD OF ~ TO ~ | III-2 PRESS ~ IN CHASSIS | III-3 SCREW ~ IN CHASSIS | III-4 FASTEN ~ IN CHASSIS |       |
| NUMBER OF FUNCTIONS FN             | 2                         | 16                     | 12                      | 5                     | 5                        | 7                     | 3                         | 3                        | 2                        | 55                        |       |
| DEFECTIVE RATE P                   | 0.001                     | 0.002                  | 0.013                   | 0.022                 | 0.005                    | 0.004                 | 0.020                     | 0.001                    | 0.001                    | 0.069                     |       |
| YIELD RATE I-P                     | 0.999                     | 0.998                  | 0.987                   | 0.978                 | 0.995                    | 0.996                 | 0.980                     | 0.999                    | 0.999                    | 0.931                     |       |
| EFFECTIVENESS OF FUNCTIONS FN(I-P) | 1.998                     | 15.968                 | 11.844                  | 4.890                 | 4.975                    | 6.972                 | 2.940                     | 2.997                    | 1.998                    | 51.205                    |       |
| ACTUAL COST CA                     | 1.25                      | 3.75                   | 1.25                    | 0.43                  | 4.41                     | 5.88                  | 1.30                      | 4.19                     | 2.94                     | 25.40                     |       |
| STANDARD COST CS                   | 1.01                      | 2.47                   | 1.18                    | 0.36                  | 3.42                     | 4.47                  | 1.18                      | 3.32                     | 2.00                     | 19.41                     |       |
| ACTUAL VALUE VA                    | 1.598                     | 4.258                  | 9.475                   | 11.372                | 1.128                    | 1.186                 | 2.262                     | 0.715                    | 0.679                    | 2.016                     |       |
| STANDARD VALUE VS                  | 1.980                     | 6.478                  | 10.169                  | 13.889                | 1.462                    | 1.566                 | 2.542                     | 0.904                    | 1.000                    | 2.834                     |       |
| VALUE RATIO VR                     | 0.81                      | 0.66                   | 0.93                    | 0.82                  | 0.77                     | 0.76                  | 0.89                      | 0.79                     | 0.68                     | 0.71                      |       |
| STARTING ORDER                     | 6                         | 1                      | 9                       | 7                     | 4                        | 3                     | 8                         | 5                        | 2                        |                           |       |

## TABLE 4-2 AFTER IMPROVEMENT

| BASIC FUNCTION                     | ASSEMBLE PARTS ON CHASSIS |                        |                         |                       |                          |                       |                           |                          |                          |                           |       |
|------------------------------------|---------------------------|------------------------|-------------------------|-----------------------|--------------------------|-----------------------|---------------------------|--------------------------|--------------------------|---------------------------|-------|
|                                    | SUBSIDIARY FUNCTION       | PREPARE ~ ON CHASSIS   |                         | SOLDER ~ TO ~         |                          |                       | FIX ~ TO ~                |                          |                          |                           | TOTAL |
|                                    |                           | I-1 STAMP ~ ON CHASSIS | I-2 INSERT ~ ON CHASSIS | II-1 SOLDER ~ BY OVEN | II-2 SOLDER ~ BY MACHINE | II-3 SOLDER ~ BY IRON | III-1 BIND LEAD OF ~ TO ~ | III-2 PRESS ~ IN CHASSIS | III-3 SCREW ~ IN CHASSIS | III-4 FASTEN ~ IN CHASSIS |       |
| NUMBER OF FUNCTIONS FN             | 2                         | 16                     | 12                      | 6                     | 4                        | 7                     | 3                         | 3                        | 2                        | 55                        |       |
| DEFECTIVE RATE P                   | 0.001                     | 0.001                  | 0.006                   | 0.002                 | 0.003                    | 0.004                 | 0.005                     | 0.001                    | 0.001                    | 0.034                     |       |
| YIELD RATE I-P                     | 0.999                     | 0.999                  | 0.994                   | 0.998                 | 0.997                    | 0.996                 | 0.995                     | 0.999                    | 0.999                    | 0.966                     |       |
| EFFECTIVENESS OF FUNCTIONS FN(I-P) | 1.998                     | 15.984                 | 11.928                  | 5.928                 | 3.988                    | 6.972                 | 2.985                     | 2.997                    | 1.998                    | 53.130                    |       |
| ACTUAL COST CA                     | 1.04                      | 3.05                   | 1.25                    | 0.61                  | 2.50                     | 5.00                  | 1.25                      | 3.75                     | 2.20                     | 20.65                     |       |
| STANDARD COST CS                   | 1.01                      | 2.47                   | 1.18                    | 0.54                  | 2.24                     | 4.47                  | 1.18                      | 3.32                     | 2.00                     | 18.41                     |       |
| ACTUAL VALUE VA                    | 1.921                     | 5.241                  | 9.542                   | 9.718                 | 1.595                    | 1.394                 | 2.388                     | 0.799                    | 0.908                    | 2.573                     |       |
| STANDARD VALUE VS                  | 1.980                     | 6.478                  | 10.169                  | 11.111                | 1.786                    | 1.566                 | 2.542                     | 0.904                    | 1.000                    | 2.988                     |       |
| VALUE RATIO VR                     | 0.97                      | 0.81                   | 0.91                    | 0.87                  | 0.89                     | 0.89                  | 0.94                      | 0.88                     | 0.91                     | 0.86                      |       |
| VALUE UP RATIO VR - 1              | 19.75%                    | 22.72%                 | 1.07%                   | 6.09%                 | 15.58%                   | 17.10%                | 5.61%                     | 11.39%                   | 33.82%                   | 21.12%                    |       |

FIG. 4-3 The Degree of Achievement in Value  $V_R$   
in "Chassis Sub-Ass'y Line"



## THE RESULT IN ACTIVITIES:

The degree of achievement in value  $V_R$  in "Chassis Sub-Ass'y Line" is shown in FIG. 4-3.

- (1) Saving money per Tuner is  $\yen 10$ .
- (2) Net saving money in a year is  $\yen 23,000,000$ .
- (3) Saving rate in all processes is 6.6 %.
- (4) Saving rate in the object process is 39.4 %.
- (5) Investment efficiency in VE is 143.75.
- (6) Saving money per hour in VE is  $\yen 115,000$ .