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27 August 1979
ENGLISH

DEVELOPMENT OF THE FURNITURE AND JOINERY INDUSTRIES AND CREATION OF A CENTRE*

DP/YUG/73/006.

YUGOSLAVIA

Technical Report: Methods improvement and work measurement

Prepared for the Government of Yugoslavia
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Vincent R. Ross, expert in industrial engineering

United Nations Industrial Development Organization
Vienna

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Explanatory notes

References to dollars ($) are to United States dollars.

The monetary unit in Yugoslavia is the dinar (Din). During the period covered by the report the value of the dinar in relation to the United States dollar was $US 1 = Din 19.00

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

OOUR stands for Osnovna Organizacija Udružestvenog Rada (Basic Associated Labour Organization).

RO stands for Radna Organizacija (Working Organization - association of OOURs).

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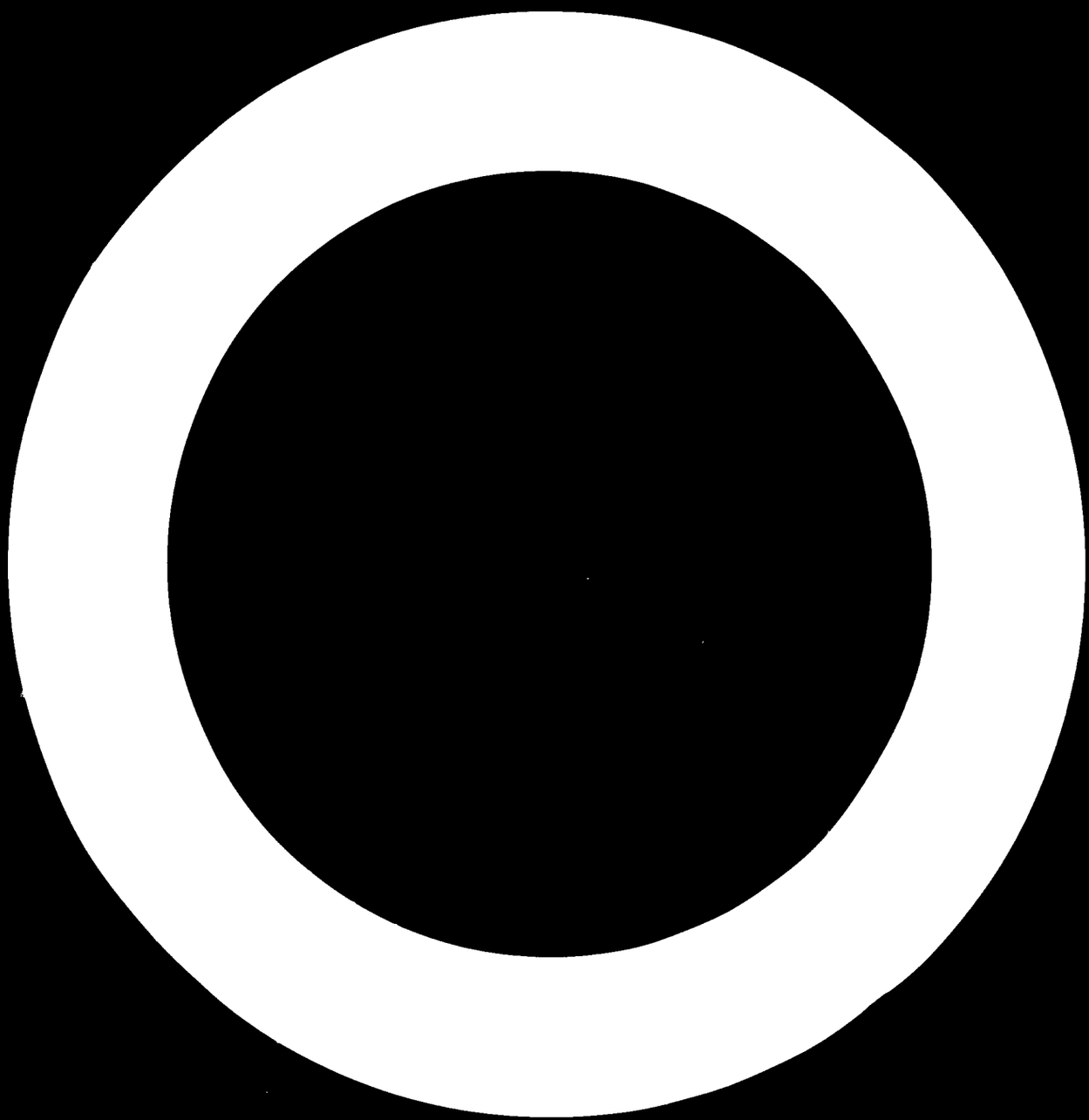
Abstract

The mission covered by this report formed part of a larger project entitled "Development of the furniture and joinery industries and creation of a centre" (DP/YUG/73/006), which was requested by the Government of Yugoslavia in December 1973 and approved by the United Nations Development Programme in August 1974, with the United Nations Industrial Development Organization (UNIDO) designated as executing agency and SIPAD, a co-operative forestry organization, as government co-operating agency.

The services of the expert were commissioned in March for the purpose of visiting Yugoslavia to meet with SIPAD officials so as to develop a practical manual for OOUR "VARDA" to be used as a training manual in such areas as the procurement, handling, seasoning and manufacture of lumber for the Yugoslav furniture industries.

A follow-up exercise by the expert and an assistant is scheduled to take place shortly for the purpose of holding seminars for the benefit of SIPAD's directors, technical staff and factory floor staff, in line with contents of this manual, prior to completion of the mission.



PREFACE

The mission covered by this report was part of a larger project entitled "Development of the furniture and joinery industries and creation of a centre" (DP/YUG/73/006), which arose from a request submitted by the Government of Yugoslavia in December 1973 and approved by the United Nations Development Programme in August 1974. The United Nations Industrial Development Organization (UNIDO) was designated as executing agency and SIPAD, a co-operative forestry industry organization comprising 126 factories, employing 55,000 persons and accounting for 65% of the saw-milling and 85% of the final products of the wood industries of the Republic of Bosnia and Herzegovina (BiH), as government co-operating agency. The project was initiated in September 1974, with a budget involving a contribution of $ 585,825 by UNDP, and of Din 19,247,900 by the Government of Yugoslavia. This manual is the result of a mission which commenced in March 1979 within the framework of the larger project.

The long-range objectives of the project are to enable the furniture and joinery industries in BiH initially, and in all of Yugoslavia eventually, to make a greater contribution to the economy. Immediate objectives are to help the industries to increase the value of their products, to improve quality, to reduce production costs, to design new products and to forecast market requirements.

The furniture and joinery industries in BiH contribute about 8% of the goods and services produced in that Republic and represent 4% of its exports. An ambitious five-year development plan is being implemented to double the production of furniture to attain a value of Din 2,000 million and to increase the work force from 6,000 to 9,000 persons. This plan calls for an investment of Din 800 million. Joinery production will increase from a vlaue of Din 200 million to Din 650 million, and the work force will triple to reach 4,500 persons, Investment of Din 950 million is foreseen for joinery plants.

The main objective of the mission was to develop a practical manual for training purposes relating to the procurement, handling, seasoning and manufacture of lumber for the benefit of the Yugoslav furniture industry. A follow-up exercise by the expert and an assistant is scheduled to take place shortly for the purpose of holding seminars for the benefit of SIPAD's director, technical staff and factory floor staff, in line with contents of this manual, prior to completion of the mission.

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I. INTRODUCTION

A. Purpose

1. To present an understanding of the applicability of video techniques to cost improvement and motion and time study in the furniture industry.

2. To present a proven approach to cost reduction in the furniture industry.

3. To present an understanding of Time and Motion Study and predetermined times, based on Methods-Time Measurement (MTM), including basic application techniques.

4. To present an understanding of the advantages, disadvantages, potentialities, and limitations of Time and Motion Study and MTM.

5. To present an understanding of the uses of Time and Motion Study, MTM, and a simplified version of MTM called Basic Standard Data.

6. To show how standard data can be developed.

A. Purpose (cont'd)

7. To describe a Rough Mill Incentive Plan which encourages maximum lumber yield.

B. Minimum Content

1. Discussion of applicability of video tape techniques to work measurement and methods improvement.

2. Introductory background to work measurement, emphasizing previous techniques, their limitations, and the evolution of MTM and one of its simplified versions.

3. Approach to plant cost reduction.

4. Brief outline of the work measurement concept of average performance and its close relationship to universal concepts of normal.

5. Basic elements of work measurement defined and discussed.

6. Fundamentals of Time and Motion Study and MTM application techniques.

7. Discussion of the uses of Time and Motion Study and MTM, including an outline of advantages and limitations of each use for:
   - analyzing, comparing, and improving methods.
   - analyzing and improving the effectiveness of machines and equipment.
   - use in cost estimating.

B. Minimum Content (cont'd)

7. - use in operator and supervisory training.
   - use in developing standard data and time formulas.

8. Discussion of simplified predetermined times (Basic Standard Data - BSD) emphasizing advantages and limitations.

9. Discussion of installation of a work measurement program in regard to contact with all individuals affected throughout the organization.

10. Discussion of the development of standard data.

11. Explanation of a Rough Mill Incentive Program.

The techniques of Time and Motion Study and MTM should be presented as complementary systems, not as opposing systems. In recent years, there has been considerable controversy about the merits of each system.

Experience teaches, however, that to do an effective job, an engineer or technician must utilize his entire bag of tricks.

C. Orientation of Class Members

Introduce class members

Introduce self to class

Brief discussion

D. Mechanics of the Course of Study

1. Course Schedule

Stressing minimum requirements and schedule to be followed, i.e., number of hours or days per week, etc. Include brief discussion of material to be covered in course--historical, application, practice periods, examinations.

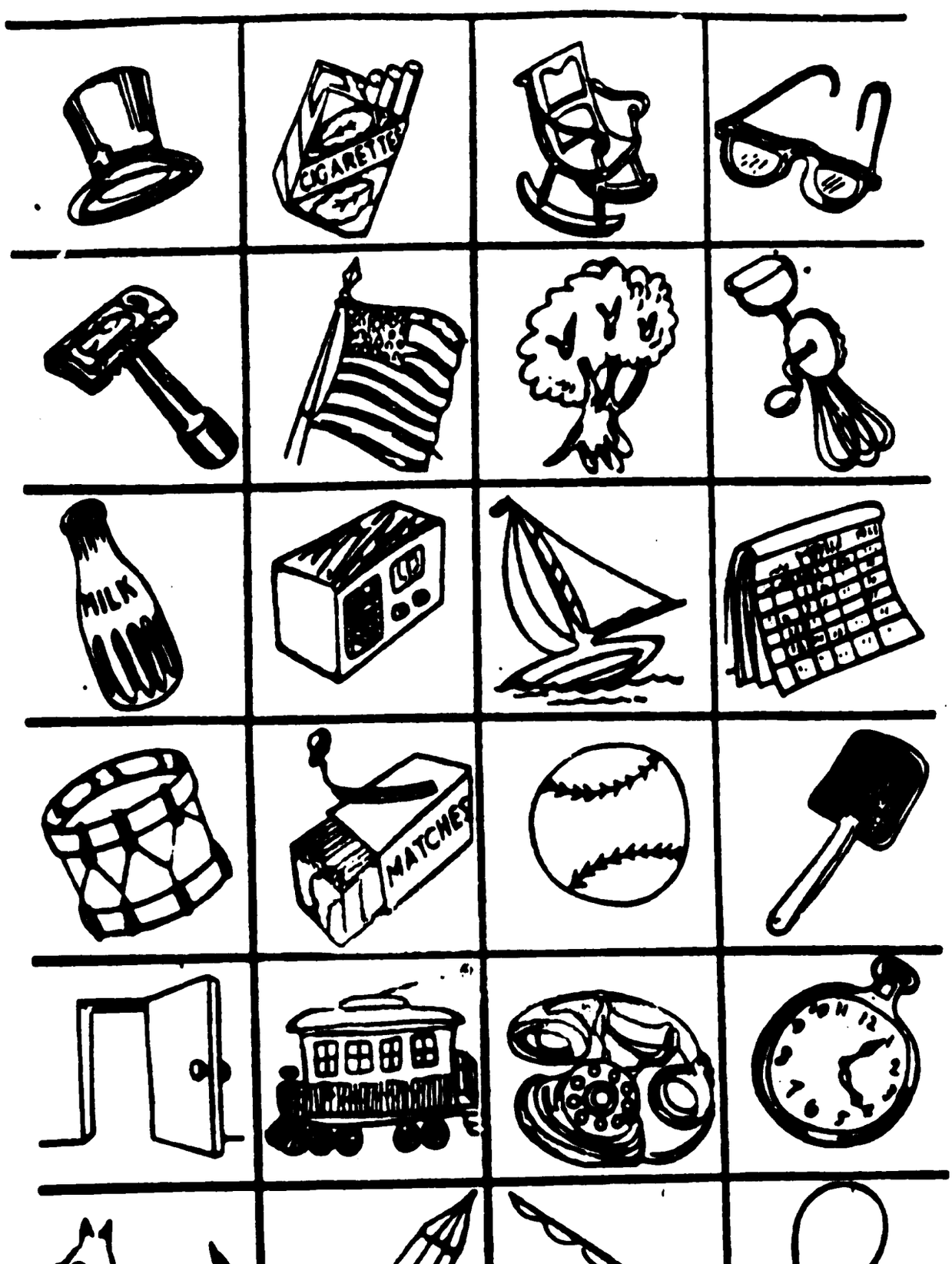
2. Training Aids

Discuss use of charts, pass-outs, and other material as aids to learning of class members.

3. Note Taking

Although much material is provided, it is essential to take comprehensive notes. Illustrate this point by means of experiment as follows: Expose Memory Test for one minute during which time class observes but does not write. Cover Memory Test and allow class 3 minutes to write down as many of the items as they can recall. Collect individual papers and score on the basis of 24 items equals 100%. Announce class average which should be about 50%. Make point that adequate notes are necessary.

Repeat experiment later to demonstrate that memory decreases as time increases. Class average should range from 35% to 40%.


CIGARETTES
MILK
MATCHES

E. What Is Work Measurement?

1. General Definition

"Work measurement offers one of the most reliable avenues or aids used by Scientific Management to achieve the benefits of increased production at lower cost for the advantage of everyone."

2. History and Development

Frederick W. Taylor - development of Time Study. Discuss briefly uses and limitations, attitude of Labor and Management.

Lillian M. and Frank Gilbreth - development of Motion Study. Discuss briefly uses and limitations.

These approaches were inadequate in themselves.

Need for a finer measurement tool--a more human and understandable approach.

3. Industry's Search for Better Techniques

Brought about by:

- increased efforts to produce more for less.
- increased emphasis on better labor-management relations.
- increased emphasis on safety.
- increased emphasis on better working conditions.
- need for pre-planning information on standards.

II. APPLICATION OF VIDEO TAPE TECHNIQUE

Take picture of audience, and play back to get their attention and interest.

A. Explain History of Application of Video Taping to Wood Industry Analyses

- Used for last 10 years in the United States.
- Take unit into plant.
- Tape operation.
- Carry unit back to office.
- Analyze over and over.
- Easy to review jobs with supervision.
- Analyst rarely fooled.
- Keep tape until rate issued.
- Can use predetermined time system or convetional time study.
- Provides record of job.
- Accepted by employee representation groups.
- Tapes in "real" time.
- Employees enjoy.
- Fast and accurate system.

B. Features of Equipment

- Battery operated, portable.
- Thirty-minute tape.
- Tape size ½-inch, reel to reel.
- Slow motion feature.
- Cost of taping unit, $2500 U.S.

B. Features of Equipment (cont'd)

- Cost per tape, $15 U.S.
- Instant replay in camera.
- No additional lighting necessary.

C. Potential as Methods Improvement Tool

- Methods improvements easily seen.
- Focal point for management meetings--e.g., review one operation per week.
- Multi-plant companies have a particular advantage.
- Also used for employee training, sales aid and personnel management tool.

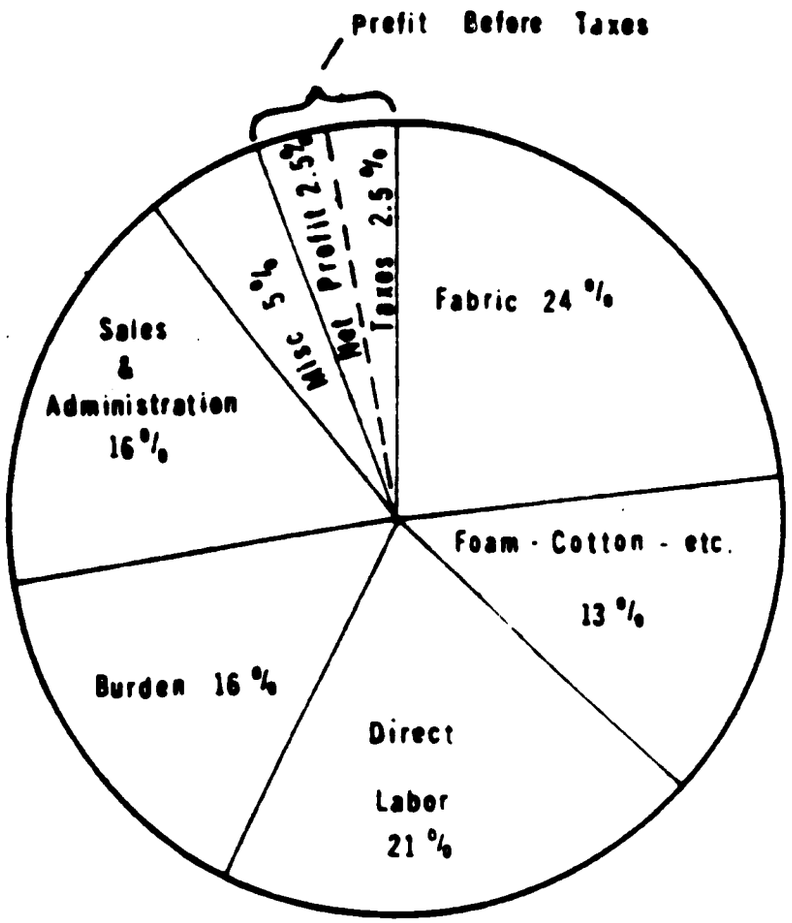
III. APPROACH TO A GENERAL COST REDUCTION PROGRAM

Now, take the audience through a program of cost reduction in the plant.

A. Introduction

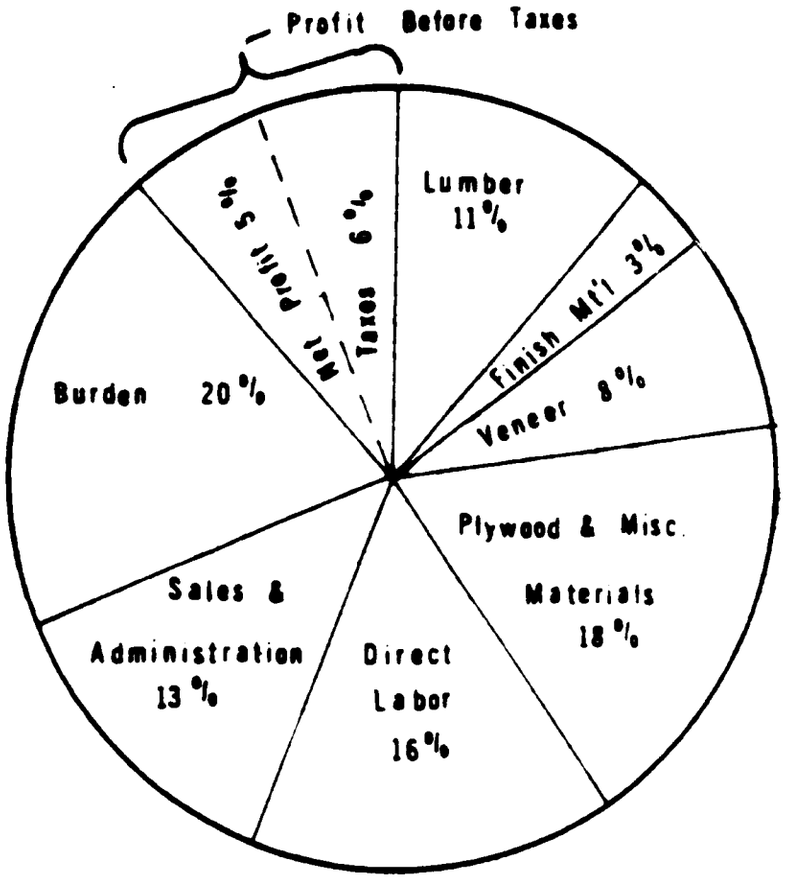
- Going to talk about Motion and Time Study and Cost Reduction.
- Notice: Say Motion Study first.
- Work out method before rate is set.
- Let's talk first about motions or, in broader sense, methods.
- Let's back up and look at a company's costs.

  Costs could be distributed like this:



Upholstery

A. Introduction (cont'd)



Casegoods

- If you are going to try to reduce costs or increase productivity, where should you start?
- Labor scattered from one end of plant to other. Often easier to improve materials utilization.
- Control of materials often in hands of just a few people.

B. Reduce Materials Costs

1. Lumber

- Usually 8 to 10% savings possible in cost of lumber.
- Refer to Standard Practice Manual.
- Refer to Rough Mill Incentive Program.

2. Finishing Material

- Spray gun techniques important.
    - Trigger gun.
    - Minimize overlap.
    - Minimize overspray and "fog" loss.
    - Determine best spraying sequence.
    - Video can help.
- Check atomization pressure and fluid flow rate.
- Savings of 10 to 15% probably possible.

3. Other Materials

- Plywood, veneer, sandpaper, glue, packing materials.
    - Check rough versus finished sizes.
    - Find small losses which accumulate.

4. Upholstering Materials

- Fabric losses.
- Miscellaneous material losses.
    - Cotton
    - Polyfoam
- Pre-cut material if possible.

B. Reduce Materials Costs (cont'd)

- Repeat: Try to effect savings in material; control is usually in the hands of a few people.
- Next: Consider labor improvement plans which can affect the entire work force (or as much of it as possible).
- Some companies have production bonus plans.
- Consider other ways to motivate workers.
- Find out where labor is being expended.
- Take a work sampling study.

C. Work Sampling Study

Sample of Work Sampling

Activities	Observations	Total	% of Total
Working	~~////~~//	7	35
Talking	////	4	20
Pushing Materials	/	1	5
Idle	//	2	10
Gone	~~////~~	5	25
Other	/	1	5
Total Observations		20	100

- Do for one to two days.
- Walk through plant; look up and mark down what you see employees doing.
- Can provide excellent picture of what is happening in a department.

C. Work Sampling Study (cont'd)

- Repeat: Do what you can to motivate entire plant.
- Department may be over-staffed if too much idleness.
- Better production control system may be needed if one department has to wait for another.
- Old story: Job will expand to fill time that is available to do the job.
- Encourage work sampling.

D. Improve Individual Jobs

After you have done everything that you can about improving over-all operation, concentrate on individual jobs.

You'll find that most jobs consist of 3 parts: get, work, and aside.

The only one that really makes your company productive is work.

1. Reduce Handling

We've had a lot of success looking at handling first (get and aside parts of job).

Principle is to reduce handling and leave more time for working.

Repeat: Review sequence of get - work on - put away.

The idea is to reduce handling.

D. Improve Individual Jobs

1. Reduce Handling (cont'd)

Example 1. Boring Machine - Bore 2 Holes

First Method	Improved Method
Get 1 piece	Get 5 pieces
Bore hole	Bore hole
Aside 1 piece	Bore hole
Get piece again	Aside 5 pieces
Bore again	
Aside again	

By combining operation, save one get, one aside per piece.

Principle: Do as much as possible to part while at machine.

Example 2. Lathe - Turning Operation

First Method	Improved Method
Get 1 piece	Get 1 piece
Turn 1 piece	Turn 1 piece and Aside previous piece while machine is turning
Aside 1 piece	

D. Improve Individual Jobs

1. Reduce Handling (cont'd)

Example 3. Boring Machine

First Method	Improved Method
Get 1 piece	Bore 1 piece and, while
Work on 1 piece	machine is boring, Aside
Put away 1 piece	5 pieces and Get new piece

While machine is boring, operator accumulates handful of finished parts, then puts away and gets next piece.

Principle: Do handling "internal" to machine cycle.

Example 4. Variety Saw

First Method	Improved Method
Get 1 piece	Get 5 pieces
Work on 1 piece	Work on 1 piece
Aside 1 piece	Aside 5 pieces

Principle: Handle in handfuls.

Consider accumulating stands or tables.

If possible, eliminate "Aside" by having automatic discharge on machine, or have operator throw piece into box.

Repeat: Address handling and reduce unproductive segment of job.

D. Improve Individual Jobs (cont'd)

2. Reduce Imbalances

In addition to handling losses just discussed, various kinds of imbalances reduce productivity within the plant.

a. Man and Man Imbalances

One man waits for another.

Example: Two people working on a glue clamp. One waits for the other.

Example: Conveyorized Rough Mills.

Example: Three people operating machine when operation could be performed by two.

Example: Whole departments lose time because of departmental capacity imbalances.

b. Man and Machine Imbalances

Example: Man waits for long stroke on a boring machine. Can he do handling internal to boring stroke?

Example: Man waits for lathe to turn.
Can man handle while lathe is turning?
Can man run two lathes?

Remember: Handling and Balance

- Handle internal to machine cycle.
- Throw pieces in box if possible.
- Discharge parts automatically.
- Handle in handfuls.
- Perform as many operations as possible per handling.

D. Improve Individual Jobs (cont'd)

Reduce balance problems.

- Man waits for man.
    - Team work situations:
        - Glue reel example
        - 3-man team delays
        - Rough Mill delays
        - Conveyor line imbalances.
- Man waits for machine.
    - Handle internal to machine cycle.
    - Run 2 machines.
    - Long strokes in boring.
    - Can speed up machine.

3. Create a Productive Atmosphere

In order to increase productivity and make the job easier for the man in the plant, you have to address the attitude of the people in the plant. They are often the experts in their field. Take advantage of their expertise. We've done this with excellent results.

Ask for help of the people, and tell them why their help is important. Often, people know what to do but don't bother because they don't realize the importance. We have to have the right attitude.

Pass out handout on reactions to suggestions.

DON'T ROCK THE BOAT

Tired of beating down new ideas? Well, here's some help. Here are 25 ready-made comments that are guaranteed to kill any new idea that comes your way.

We tried that before.
We've never done it before.
I know a fellow who tried it.
We've always done it this way.
It's too radical a change.
Why change it? It's still working O.K.
We did all right without it.
It's too much trouble to change.
Our place is different.
The men will never buy it.
Customers won't like it.
We don't have the time.
Not enough help.
It costs too much.
It would run up the overhead.
We're not ready for that.
Let's put it in writing.
We should test it first.
Let's give it more thought.
Let's all sleep on it.
Shelve it for the time being.
You're right, but...
Good thought, but impractical.
It can't be done.
It's impossible.

D. Improve Individual Jobs

3. Create a Productive Atmosphere (cont'd)

The point is that people in general resist change, but change is just another name for progress.

Read the following on Productivity and Competition:

a. As an example of competitors' attitudes found in some industries, one executive said: "If I find that an operation has been done in my plant the same way for six months, I question it; if it has been done the same way for a year, I know damn well it should be questioned." G.E. says: "Our most important product is progress."

b. History shows that the only thing constant is change. Whether you bring it about or not, it will occur. The sharpest personal effect on you as a worker or manager is the effect of increased productivity in the hands of your competitors.

c. "Remember that no war, no strike, or no depression can so completely wreck an established business as can new and better methods in the hands of an enlightened competitor." Thompson. Products Work Simplification Manual.

d. If there is a loss of jobs due to new and better methods, it is due to new and better methods in the competitors' plants, not in ours.

D. Improve Individual Jobs

3. Create a Productive Atmosphere (cont'd)

In order to make progress, we have to "stick our neck out." Someone said: "Behold, the turtle makes progress only when he sticks his neck out."

We probably won't trip if we keep both feet on the ground, but we won't get very far either.

Pass out the Twenty Principles of Motion Economy and explain.

Question everything: how, what, where, when, why, who. Ask your people to ask why and communicate to you.

TWENTY PRINCIPLES OF MOTION ECONOMY

Check each job against this list of principles to see what changes may be made to improve the method and reduce fatigue, in your search for the "One Best Way".

1. Begin each element simultaneously with both hands.
2. End each element simultaneously with both hands.
3. Use simultaneous arm motions in opposite and symmetrical directions.
4. Use hand motions of lowest classification for satisfactory operations.
5. Keep motion path within normal working area.
6. Avoid sharp changes of direction. Plan a smoothly curved motion path.
7. Slide small objects. Avoid pick up and carry.
8. Locate tools and materials in proper sequence, at fixed work stations.
9. Use fewest elements to obtain shortest time.
10. Use rhythm and automaticity to increase output and lessen fatigue.
11. Relieve hands with foot pedals where possible.
12. Avoid holding. Use vise or fixture, freeing hands to move pieces.
13. Provide foot-operated ejectors to remove finished pieces.
14. Use drop delivery where possible.
15. Shorten transports by keeping materials nearby in gravity-feed hoppers.
16. Preposition tools for quick grasp.
17. Preposition product for next operation.
18. Locate machine controls nearby for ease of operation.
19. Design workplace height for sitting-standing arrangement, and provide proper height chair with comfortable seat and backrest for good posture.
20. Provide pleasant working conditions considering illumination, temperature, humidity, dust, fumes, ventilation, noise level, color scheme, orderliness, and the like.

IV. MOTION AND TIME STUDY - GENERAL

A. Why Time Study

We've talked thus far about the Motion or Methods part of our subject, Motion and Time Study. Let's talk about the Time Study phase now.

Time Study is sometimes emotional, especially if you have a wage incentive plan.

Use video analysis for setting standards.

- Removes many pressures.
- Supervision has a chance to look at tapes.
- Engineer has a chance to study.

First of all, why do we need Time Study? To harass workers? No. We need it, first of all, to help us figure out what our costs are.

If we don't know what our costs are, we're not too comfortable setting our selling prices.

How does Time Study help determine costs? Well, let's see. Suppose you want to find out what the labor content is for a part. You first list all operations on that part, then apply time standards to each operation (including set-up costs), and then factor for operator efficiency.

A. Why Time Study (cont'd)

Operation	Operation Time/100 Pcs.
Cut-Off	2 min.
Rip	3 min.
Glue	4 min.
Plane	2 min.
Tenon	3 min.
Shape	12 min.
Bore	4 min.
Bore	1 min.Z
	31 min./100 pcs.

31 min./100 pcs. x $.02/min. = $.62/100 Direct Labor

Labor at 60% performance = $1.03

Other things go into establishing a selling price, but it's nice to have a guide.

Without time standards, you can still see through accounting reports whether your company is making a profit, but it's hard to keep track of it by product. You may be making money on one product and losing on another. Time standards let you look at your product line individually.

Time standards also help in planning. If you have to make 1,000 XYZ parts and each one of them is going to take 1 minute at the band saw if they're done in standard time, then you've got 1,000

A. Why Time Study (cont'd)

minutes worth of band saw work to do over some time period. Once you know this, you can consider overtime, a partial second shift, another band saw, and so on.

Time standards also help in performance evaluation. History shows us this.

Companies without measured work usually perform at about 60% efficiency, compared with "standard performance" of 100%. (These plants would be termed "day-work" plants.)

Companies with time standards which are used in performance evaluation usually perform at 80 to 85% efficiency. (These plants would be termed "measured day-work" plants.)

Companies with good time standards which are used for incentive plans, where pay is influenced by worker productivity, usually produce at the 115 to 120% level. (These plants are termed "incentive" plants.)

Thus, through the development and use of standards in a measured day-work situation, production can often be increased 42%. ($\frac{85\%}{60\%} = 1.42\%$).

Incentive plants are often 100% more productive than day-work plants.

Perhaps a company can avoid building a new plant by installing an incentive system.

A. Why Time Study (cont'd)

Another thing that Time Study does is to establish a method. The engineering department, of course, should be kept informed of any changes in the method so that the time standards can be changed to reflect the new method.

Also, if the proper feedback system is created, the time study system will highlight problem areas for corrective action. If it is seen that very poor operator performance is occurring at a particular location in the plant, corrective measures can be implemented.

A document which is useful in highlighting problem areas is called an "Off Standard" report. This report indicates problems which workers encounter which force them to deviate from the method on which the time standard was based and hence go "off standard".

In summary, Time Study is needed to:

- help determine costs, selling prices.
- aid in planning.
- help in performance evaluation.
- establish a method.
- help in operation improvement.

B. What Is a Time Standard?

It is a quantity of time required to perform an operation by an average operator, who is fully trained and qualified, working under normal conditions at an average pace, including allowances for fatigue, personal needs, and delay time.

1. Break Down Definition

Time

- Can be in minutes or decimal hours.
- Different preferences.

Perform an Operation

- Methods study first; at least an acceptable method.
- Use video tape; review with Foreman if necessary.

Fully Trained

- Not trainee rates.
- Knows job.

Average Operator and Average Pace

- Not add up all operators and divide by number.
- Mental picture; this is a problem area.
    - Some companies use MTM or BSD.
- Or, adjust to average performance through leveling factor if using time study.

The 100% pace is a pace which an operator can perform day after day without undue exertion. It is considered to be the pace of a fair day's work.

B. What Is a Time Standard?

1. Break Down Definition (cont'd)

Suppose you time a job, and operation takes 1 minute. You level the operator's performance at 90%. Allowed time for the job would then be:

1 min. x .90 leveling factor = .90 min. plus allowances.

2. Allowances

The allowances are an add-on factor to account for the fact that during the day the operator is going to lose some time due to:

a. Personal reasons:
   - Breaks
   - Other personal.

b. Fatigue.

c. Delays:
   - Drops tools
   - Supervisor interruption, etc.

This allowance is often about 15% (established by custom). Thus, the .9 minute leveled time mentioned before would be increased by a factor of 1.15% to 1.035 minutes allowed time.

Leveled Time		Allowance		(Standard) Allowed Time
.9	x	1.15	=	1.035

Allowances are established through custom usually so that people on incentive could average a 20% bonus.

B. What Is a Time Standard? (cont'd)

3. Use of Standards

Show how standard is used on a daily basis.

Worker Jones

	Units		Time Standard		Earned Time
Production -	10	x	5 min.	=	50
	30	x	10 min.	=	300
	5	x	15 min.	=	75
	20	x	3 min.	=	60
					485 minutes

Clock Time - 480 minutes

Off Standard - 40 minutes

On Standard 440 minutes

Performance $\frac{485 \text{ minutes}}{440 \text{ minutes}} = 110\%$

Have Off Standard Report to explain 40 minutes.

Report percentage of time On Standard.

$$\frac{440 \text{ minutes}}{480 \text{ minutes}} = 92\%$$

C. Major Types of Work Measurement

1. Time and Motion Study

"Time and Motion Study is the analysis of the methods, of the materials, and of the tools and equipment used in the performance of a piece of work."

C. Major Types of Work Measurement (cont'd)

2. Methods-Time Measurement (MTM)

"Methods-Time Measurement is a procedure which analyzes any manual operation or method into basic motions required to perform it and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made."

3. Simplified Predetermined Times (Basic Standard Data)

Essentially the same procedure as MTM. The technique has been simplified and analysis time reduced by taking advantage of averaging and compensating variations.

D. Concept of Average Performance

1. Background of Performance Rating

Concepts of what constitutes a fair day's work continues to be an industrial engineer's problem.

Mathematical approaches--leveling, statistical averages.

2. Factors Influencing Performance

a. Skill

b. Effort

c. Conditions.

Conditions for the most part can be easily fixed or determined. This places the emphasis on skill and effort.

D. Concept of Average Performance (cont'd)

3. Skill and Effort - (Pass out Skill and Effort sheet)

Skill can be classified into six degrees.

For skill: Poor, Fair, Average, Good, Excellent, and Superskill.

For effort: Poor, Fair, Average, Good, Excellent, and Excessive.

MTM times are based on Average Performance.

Time and Motion Study times are "leveled" or "rated" to give Average Performance.

Average must then be defined accurately to give consistency to results of different observers.

4. Skill

The leveling procedure used in collecting work measurement data defines Average Skill as:

> The skill of a person who has performed a job long enough to proceed without Excessive Fumbling, Planning, or Errors. He need not be noticeably good or poor.

5. Effort

Average effort is: A pace at which a person would proceed day after day without exerting himself.

Or, the pace of the conscientious day worker drawing a good base wage.

SKILL

SUPER SKILL: $A_1 = +0.15$ $A = +0.14$ $A_2 = +0.13$

The operator of excellent skill p. rfected - Has been at the work for years - Naturally suited to the work - Works like a machine - Motions so quick and smooth that they are hard to follow - Does not seem to have to think about what he is doing - Elements of operation blend into one another so that division points are difficult to recognize - Conspicuously the best worker of all.

EXCELLENT SKILL: $B_1 = +0.11$ $B = +0.095$ $B_2 = +0.08$

Precision of action - Shows speed and smoothness in performance - Thoroughly familiar with work - Makes no mistakes - Works accurately with little measuring or checking - Operates his machine or tools to best advantage - Works rhythmically and with coordination - Makes speed without sacrificing quality - Has full self-confidence - Possesses high natural aptitude for work at hand.

GOOD SKILL: $C_1 = +0.06$ $C = +0.045$ $C_2 = +0.03$

Noticeably better than ordinary run of men - Markedly intelligent - Possesses good reasoning ability - Hesitation entirely eliminated - Needs little supervision - Works at steady pace - Fairly quick in motions - Works correctly to specifications - Can instruct others less skilled - Motions well coordinated.

AVERAGE SKILL: $D = 0.00$

Works with reasonable accuracy - Has self-confidence - Is proficient at the work - Follows a set procedure without appreciable hesitation - Understands his tools and equipment - Plans ahead - Coordinates hand and mind - Reads drawings well - Appears a little slow in motions - Turns out satisfactory work.

FAIR SKILL: $E_1 = -0.05$ $E = -0.075$ $E_2 = -0.10$

Misfit on job for a long time - Comparatively new man - Follows proper sequence of operations without much hesitation - Somewhat clumsy and uncertain but knows what he is doing - Fairly familiar with equipment and surroundings - Plans ahead to some extent - Lacks full self-confidence - Loses time due to own blunders - Can read drawings fairly well - Gets some output with less effort than poor man.

POOR SKILL: $F_1 = -0.16$ $F = -0.19$ $F_2 = -0.22$

New man or misfit - Unfamiliar with the work - Uncertain of proper sequence of operations - Hesitates between operations - Makes many errors - Movements clumsy and awkward - Does not coordinate mind and hands - Lacks self-confidence - Can not read drawings well - Unable to think for himself.

EFFORT

EXCESSIVE EFFORT: $A_1 = +0.13$ $A = +0.125$ $A_2 = +0.12$

Extends himself to pace impossible to maintain steadily - Best effort from every standpoint but that of health.

EXCELLENT EFFORT: $B_1 = +0.10$ $B = +0.09$ $B_2 = +0.08$

Works fast - Uses head as well as hands - Takes keen interest in work - Receives and makes many suggestions - Has utmost confidence in time study man - Cannot keep up effort more than a few days - Endeavors to show superiority - Uses best equipment and methods available; (b) Reduces false motions to a minimum. (c) Works systematically to best of his ability.

GOOD EFFORT: $C_1 = +0.05$ $C = +0.035$ $C_2 = +0.02$

Little or no lost time - Takes an interest in the work - Takes no notice of time study man - Works at best pace suited for endurance - Conscientious about his work - Steady and reliable - Follows accepted method; (b) Well prepared for job and has workplace in order

AVERAGE EFFORT: $D = 0.00$

Better than fair; poorer than good - Works steadily - May somewhat doubt fairness of time study man or management - Accepts suggestions, but makes none - Seems to hold back his effort - With respect to method; (a) Has good setup, (b) Plans ahead, (c) Works with good system, (d) Reduces lost motions.

FAIR EFFORT: $E_1 = -0.04$ $E = -0.06$ $E_2 = -0.08$

Same general tendencies as poor effort but of lessened intensity - Accepts suggestions grudgingly - Attention appears to wander from work - Possibly affected by late hours, dissipation, or mental worries - Puts some energy into work - Method used improper as follows: (a) Fairly systematic but does not always follow same sequence. (b) Somewhat too accurate. (c) Makes jobs unduly hard. (d) Does not use best tools. (e) Seems purposely somewhat ignorant of the work at hand.

POOR EFFORT: $F_1 = -0.12$ $F = -0.145$ $F_2 = -0.17$

Obviously kills time - Lacks interest in work - Resents suggestions - Works slowly and appears lazy - Attempts to extend time through improper method by: (a) Making unnecessary trips for tools and supplies. (b) Making two motions where one would do. (c) Having poor setup or workplace layout. (d) Doing work more accurately than necessary. (e) Purposely using wrong or poor tools.

SKILL			EFFORT		
+0.15	A_1	Super	+0.13	A_1	Excessive
+0.13	A_2		+0.12	A_2	
+0.11	B_1	Excellent	+0.10	B_1	Excellent
+0.08	B_2		+0.08	B_2	
+0.06	C_1	Good	+0.05	C_1	Good
+0.03	C_2		+0.02	C_2	
0.00	D	Average	0.00	D	Average
-0.06	E_1	Fair	-0.04	E_1	Fair
-0.10	E_2		-0.08	E_2	
-0.16	F_1	Poor	-0.12	F_1	Poor
-0.22	F_2		-0.17	F_2	

CONDITIONS			CONSISTENCY		
+0.06	A	Ideal	+0.04	A	Perfect
+0.04	B	Excellent	+0.03	B	Excellent
+0.02	C	Good	+0.01	C	Good
0.00	D	Average	0.00	D	Average
-0.03	E	Fair	-0.02	E	Fair
-0.07	F	Poor	-0.04	F	Poor

D. Concept of Average Performance

5. Effort (cont'd)

Or, the pace at which no bonus is earned or lost on many incentive plans.

Many plants find it necessary to adapt this concept of average to their own.

This can be effected by simply applying a percentage factor to MTM or leveled Time and Motion Study times.

6. Make-Out on Standards

Discussion of performance is not complete without stressing the importance of method.

It is difficult to compare performance at different levels of skill or effort without consideration of method.

Operators working at high skill or effort levels tend to "short-cut" or completely change the method or motion pattern.

This results in a time reduction due not only to skill and effort but also to elimination of motions. For example. a better than average operator may perform at 110%; at that performance, the motion pattern may be reduced by 10%. The resulting make-out: 1.10 x 1.10 equals 121%.

Properly set standards allow approximately 20% make-out for the average worker on a good incentive plan.

D. Concept of Average Performance

6. Make-Out on Standards (cont'd)

This does not mean the top is 20%. Depending upon the methods "short-cutting" possibilities, some operators may exceed standards by 40% or better.

7. Concept of Normal

Although concept of normal varies somewhat from plant to plant, most of the variation is due to make-out on existing incentive plans and not basic concept itself. For example:

- Looseness of old rates.
- Earnings on present standards.
- Negotiated rates.
- "Goodwill Adjustments" made by members of higher management.
- Stop watch time values and MTM values.

Throughout U. S. and abroad, very close concept or correlation of normal.

Adjustments made on MTM and good Time and Motion Study rates in industry--not due to basic concept, but to line up with existing earnings.

Actually a monetary adjustment--not a time adjustment.

Through rating films, clinics, training programs, closer and closer agreement on "normal".

D. Concept of Average Performance (cont'd)

8. Accuracy of MTM

MTM values have proven highly accurate in a wide variety of plants. In addition, they have been subjected to study by independent engineers.

Confirmation Studies of MTM - Time Study Comparison

- 27 simultaneous MTM and stop watch time studies made by a qualified engineer and time study man on a variety of jobs.
- Results varied by less than 1/16 of 1%.
- Cornell Report--published by Sibley School of Engineering to determine reproductibility of MTM time values. Very close correlation--27/100 of 1% variation on over-all observations.

E. Work Measurement Definitions and Terms

1. Allowances

A time allowance, generally in percentages, is added to the base time required to perform the normal work in order to take into account short delays and interruptions which do not happen regularly but nevertheless affect the number of pieces produced over a period of time. The allowance factor which will be used will be determined by detailed studies in the plant.

E. Work Measurement Definitions and Terms (cont'd)

2. Allowed Time

Allowed time is the resulting standard time for a given operation after the base time required to do the work is increased by personal, fatigue, and delay allowances. (Standard and allowed time are the same.)

3. Average Effort

Average effort is characterized by a pace which can be maintained by an operator day in and day out over a long period of time without physical or mental injury. It is a pace which can be increased by the operator's "will to work".

4. Average Skill

Average skill means that an operator has had sufficient practice to follow a given method without hesitation--that he knows the workplace, appears "at home" on the job, and turns out acceptable quality production.

5. Base Rate

Base rate is the guaranteed minimum hourly rate of pay to be paid an operator for each hour worked at a given class of work.

6. Base Time

Base time is the total time in TMU's required to perform all motions of an element or operation as determined from the MTM or BSD Data Card.

E. Work Measurement Definitions and Terms (cont'd)

7. Bonus Hours

Bonus hours is the time in hours given as a bonus for meeting or exceeding standard. This bonus is added to the hours earned before computing earnings.

8. Day Work

Day work is any work authorized by a supervisor when the operator is not working on incentive for various reasons. Authorized day work is not chargeable against the hours worked on incentive. Payment for such time is computed by multiplying the time spent on day work by the operator's base rate.

9. Decimal Hours

Decimal hours are fractional parts of any hour expressed in decimals. For example: 1/2 hour - .5000 hour; 1/10 hour - .1000 hour; 1/1000 hour - .0010 hour.

10. Delays - Avoidable

Avoidable delays are those portions of a day or work period which are within control of the operator during which he is idle or doing things not related to the job, but not including the time allowed for personal necessities, fatigue, and unavoidable delays.

E. Work Measurement Definitions and Terms (cont'd)

11. Delays - Unavoidable

No matter how well the work is planned by management and/or the operator, certain unavoidable delays will occur periodically, completely outside of the operator's control, which must be accounted for in the standard by the addition of the necessary time to allow for such delays. Such allowance is included in the standard usually as a percentage of the base time.

12. Earned Rate

Earned rate is the average hourly earnings for each hour worked, which is computed by dividing the total earnings for a period by the hours worked.

13. Effort

Effort is characterized principally by concentration and attention to the work and upon speed of movements in performing the work.

14. Elements

Elements are a combination of motions used to perform a given job or portion of that job.

15. Fatigue

Fatigue is a physical and/or mental condition existing in a person resulting in lack of interest in work, reduced production, or the inability to do more work.

E. Work Measurement Definitions and Terms (cont'd)

16. Fatigue Allowance

Fatigue allowance is the time included in the standard, usually as a percentage of the base time, to compensate a workman for the rest period or its equivalent which is needed by the workman to enable him to continue to produce at the standard pace.

17. Gross Earnings

Gross earnings are the total wages to be paid to a man for a given period before deductions. Gross earnings are computed by multiplying the man's base rate per hour times the net hours. A slight additional calculation is necessary to compute earnings when overtime is involved.

18. Hours Earned

Hours earned is the total time earned by an operator in a given period of time. It is determined by multiplying the total number of pieces produced times the allowed time per piece.

19. Hours Worked on Day Work

Hours worked on day work is the total unit time spent by an operator working on jobs on authorized day work, or on jobs for which there is no incentive standard. Such time is not charged against the operator in computing hours worked on incentive.

E. Work Measurement Definitions and Terms (cont'd)

20. Hours Worked on Incentive

Hours worked on incentive is the total time spent by an operator working on incentive standards.

21. Incentive Pace

An incentive pace is a pace above that required to meet standard. However, it is a pace which an average qualified workman can maintain throughout the shift without physical or mental injury when provided with personal, fatigue, and delay allowances. Such a pace, if maintained, results in increased earnings for the workman when working under an incentive plan.

22. Make-Out

Make-out is the point at which the earned hours equal or exceed the hours worked on incentive.

23. Method

Method is the procedure to be followed in performing an operation or job and includes such items as tools, machines, quality requirements, arrangement of the workplace, the number, type, and sequence of motions required to perform that job.

24. Motion

A motion is a short movement of the body or body members which is analyzed, classified, and recorded in accordance with approved procedure.

E. Work Measurement Definitions and Terms (cont'd)

25. MTM, Methods-Time Measurement

Methods-Time Measurement is a procedure which analyzes any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made.

26. Net Hours

Net hours are the total hours for which a man will be paid for any given period of time (that is, day or week) and includes total earned hours, bonus hours, and day work hours.

27. Performance Rating

An attempt to evaluate in quantitative measure the time effect of the qualitative behavior of the operator.

28. Percent Performance

Percent performance is the percentage of the standard obtained by an operator. It is computed by dividing the hours earned by the hours worked on incentive.

29. Personal Allowance

Personal allowance is that time included in the standard, usually as a percentage of the base time, to compensate a workman for the period required to attend to personal necessities such as obtaining drinks of water, making necessary trips to the toilet, and the like.

E. Work Measurement Definitions and Terms (cont'd)

30. Set-Up

Set-up is the work that must be performed before starting production on a different operation.

31. Skill

Skill is generally referred to as efficiency at following a given method, or economical use of energy, in performing an operation so that no unnecessary movements or hesitations enter into the performance of the job.

32. Standard

A standard is the total time allowed an operator to produce one piece or to perform a definite amount of work following a specific method on which the standard is based.

33. TMU, Time Measurement Unit

A TMU is an arbitrary chosen unit of measurement of .00001 hour, so that the units of time used in MTM data can be expressed in whole numbers which are easily remembered. TMU's are converted into hours by multiplying by .00001 or moving the decimal place five places to the left. TMU's do not include any allowance for fatigue, personal necessities, or unavoidable delays.

34. Time and Motion Study

Time and Motion Study is the analysis of the methods, of the materials, and of the tools and equipment used in the performance of a piece of work.

E. Work Measurement Definitions and Terms (cont'd)

35. Watch Reading

Time recorded from a stop watch (usually a standard hour watch) onto a Time Study Sheet.

F. Problem Sheet for Comparison of Time Unit Systems

1. Express 1 hour in terms of

   decimal hours _____

   decimal minutes _____

   TMU _____

2. Express 1 minute in terms of

   decimal hours _____

   decimal minutes _____

   TMU _____

3. Express 1 second in terms of

   decimal hours _____

   decimal minutes _____

   TMU _____

4. Express 100 TMU in terms of

   decimal hours _____

   decimal minutes _____

   seconds _____

5. An MTM analysis gives a value of 236 TMU for a given operation before adding any allowance factors. A comparative time study arrives at a leveled value of .1416 decimal minutes for the same operation. What is the percentage of difference between the two values? _____

6. A 14-inch Reach to an object in a fixed location has a value of 10.5 TMU. What is this expressed in

   decimal hours _____

   decimal minutes _____

G. Four Parts of a Time and Motion Study

1. Finding the most economical way of doing a job.

2. Standardizing the methods, materials, tools, and equipment.

3. Accurately determining the time required by a qualified and properly trained person working a normal pace to do the task.

4. Assisting in training the worker in the new method as necessary.

H. Steps in Taking a Time Study

1. Contact the supervisor.

2. Check the operation for method.

3. Obtain all information that is necessary and record on Time Study Sheet.

4. Divide the operation into elements.

5. Select an operator to be studied.

6. Record the elemental times.

7. Rate the performance.

8. Calculate the standard time.

9. Summarize all studies.

H. Steps in Taking a Time Study (cont'd)

10. Record occurrence factors (sometimes referred to as frequencies) and PFD (personal, fatigue, and delay) allowances.

11. Prepare the Standard Practice Bulletins.

I. Watch Reading

Two most commonly used methods are:

1. Continuous timing
2. Repetitive timing (commonly known as "snap-back").

Continuous method gives exact sequence of elements in the operation. Also gives total time at end of study.

Snap-back usually produces more accurate elemental times because the pressure of reading the watch "instantly" is not present as in the continuous method.

Practice watch reading with a Standard Hour Watch.

Compare Standard Hour Watch with TMU watch to illustrate visually the difference in the length of the time units ascribed to each watch.

J. Performance Rating

Definition: "An attempt to evaluate in quantitative measure the time effect of the qualitative behavior of the operator."

Two general systems in use:

1. Speed rating technique used with SAM rating films.
2. LMS technique developed by Lowry, Maynard, and Stegmerten.

J. Performance Rating (cont'd)

The SAM procedure judges over-all performance--probably the most widely used.

The LMS procedure treats human variables separately.

The LMS system assigns point values to Skill, Effort, Conditions, and Consistency. Points are added up and converted to % performance.

K. Time Studies on Job

Equipment needed:

1. Time Study watch
2. Time Study board (clip board can also be used)
3. Time Study Record (Observation Sheet).

L. Calculate Studies

The "raw" or base time is first calculated by adding the individual elemental times (observations) in each element and dividing by the total number of observations per element.

The performance rating is then multiplied by the "raw" or base time to give a rated time.

To calculate a standard time, multiply the rated time by the necessary allowances. These allowances are usually referred to as PFD (personal, fatigue, and delay). The "delay" portion is unavoidable. Avoidable delays are within the operator's control, and no time allowance is provided.

TIME STUDY RECORD

DATE | DEPT. | SHIFT

DETAILS OF OPERATION

DATA

PEGBOARD OPERATION

OPERATOR

TIMER

[X]

DETAILS OF OPERATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TIME NO. OCC	PERF. RATING	NORMAL TIME
1. Remove pegboard from storage, position in workplace.	5	7	6	7	7	6	6	5	9	6	6	6	7	2	7	6							
2. Place pegs in pegboard 2 at a time.	13	12	15	16	17	17	15	15	14	15	13	15	14	14	14	14	13	13	14	13			
	13	14	13	14	11	12	13	12	11	14	13	13	15	16	12	14	14	12	12	14			
	18	14	14	14	13	13	14	15															
3. Set full pegboard aside.	7	6	6	5	7	6	6	4	7	7	7	4	7	6	6	4							
4. Get full pegboard, remove pegs from board, place pegs in box.	13	8	14	9	14	8	17	9	13	8	13	8	13	9	16	9	12	8	13	9			
	14	8	15	9	13	8	14	9	15	7	16	9											
5. Place empty pegboard aside.	6	6	6	8	7	7	7	7	7	6	6	7	7	6	7	6							
6. Exchange peg boxes as necessary.	14	11	15	11																			
7. Miscellaneous time.																							

13.80
13.78
.02
.14%

FORM 1030 (8.11.60)

V. FUNDAMENTALS OF METHODS-TIME MEASUREMENT (MTM)

A. Reason for Familiarization (Use Data Card)

To give student broad concept of use and application of MTM data.

B. Time Measurement Units

Examine the TMU, what it is, and why it was selected.

1 TMU equals 1/100,000 of one hour

6/10,000 of one minute

or 36/1000 of one second

To convert 220 TMU's

to hours, point off 5 places to left - .00220

to minutes, multiply by .0006 - .1320 minutes

to seconds, multiply by .036 - 7.920 seconds.

C. Why TMU Selected

The units were based on hour multiples because of widespread usage of the standard hour.

The original data had been compiled in 1/16 seconds. This is related to 16 frames per second (speed of camera).

Example: Simple G1A equals 2.0 TMU, averaging slightly more than 1 frame (1/16 second).

Arbitrary adoption of multiples of 1 hour seemed to be simplest and best solution.

REACH–R

Distance Moved in cm	Time TMU						CASE AND DESCRIPTION
	R-A	R-B	R-C R-D	R-E	mR-A R-A	mR-B R-B	
2 or less	2.0	2.0	2.0	2.0	1.4	1.4	A Reach to object in fixed location, or to object in other hand or on which other hand rests.
4	3.4	3.4	5.1	3.2	3.0	2.4	
6	4.5	4.5	6.5	4.4	3.9	3.1	
8	5.5	5.5	7.5	5.5	4.6	3.7	
10	6.1	6.3	8.4	6.8	4.9	4.3	
12	6.4	7.4	9.1	7.3	5.2	4.8	
14	6.8	8.2	9.7	7.8	5.5	5.4	B Reach to single object in location which may vary slightly from cycle to cycle.
16	7.1	8.8	10.3	8.2	5.8	5.9	
18	7.5	9.4	10.8	8.7	6.1	6.5	
20	7.8	10.0	11.4	9.2	6.5	7.1	
22	8.1	10.5	11.9	9.7	6.8	7.7	
24	8.5	11.1	12.5	10.2	7.1	8.2	C Reach to object jumbled with other objects in a group so that search and select occur.
26	8.8	11.7	13.0	10.7	7.4	8.8	
28	9.2	12.2	13.6	11.2	7.7	9.4	
30	9.5	12.8	14.1	11.7	8.0	9.9	
35	10.4	14.2	15.5	12.9	8.8	11.4	D Reach to a very small object or where accurate grasp is required.
40	11.3	15.6	16.8	14.1	9.6	12.8	
45	12.1	17.0	18.2	15.3	10.4	14.2	
50	13.0	18.4	19.6	16.5	11.2	15.7	
55	13.9	19.8	20.9	17.8	12.0	17.1	E Reach to indefinite location to get hand in position for body balance or next motion or out of way.
60	14.7	21.2	22.3	19.0	12.8	18.5	
65	15.6	22.6	23.6	20.2	13.5	19.9	
70	16.5	24.1	25.0	21.4	14.3	21.4	
75	17.3	25.5	26.4	22.6	15.1	22.8	
80	18.2	26.9	27.7	23.9	15.9	24.2	

MOVE–M

Distance Moved in cm	Time TMU				Wt. Allowance			CASE AND DESCRIPTION
	M-A	M-B	M-C	mM-B M-B	Weight Kg	Factor	Constant TMU	
2 or less	2.0	2.0	2.0	1.7	1	1.00	0.0	A Move object to other hand or against stop.
4	3.1	4.0	4.5	2.8				
6	4.1	5.0	5.8	3.1	2	1.04	1.6	
8	5.1	5.9	6.9	3.7				
10	6.0	6.8	7.9	4.3	4	1.07	2.8	
12	6.9	7.7	8.8	4.9				
14	7.7	8.5	9.8	5.4	6	1.12	4.3	
16	8.3	9.2	10.5	6.0				
18	9.0	9.8	11.1	6.5	8	1.17	5.8	
20	9.6	10.5	11.7	7.1				B Move object to approximate or indefinite location.
22	10.2	11.2	12.4	7.6	10	1.22	7.3	
24	10.8	11.8	13.0	8.2				
26	11.5	12.3	13.7	8.7	12	1.27	8.8	
28	12.1	12.8	14.4	9.3				
30	12.7	13.3	15.1	9.8	14	1.32	10.4	
35	14.3	14.5	16.8	11.2				
40	15.8	15.6	18.5	12.6	16	1.36	11.9	C Move object to exact location.
45	17.4	16.8	20.1	14.0				
50	19.0	18.0	21.8	15.4	18	1.41	13.4	
55	20.5	19.2	23.5	16.8				
60	22.1	20.4	25.2	18.2	20	1.46	14.9	
65	23.6	21.6	26.9	19.5				
70	25.2	22.8	28.6	20.9	22	1.51	16.4	
75	26.7	24.0	30.3	22.3				
80	28.3	25.2	32.0	23.7				

APPLY PRESSURE–AP

Case	TMU	DESCRIPTION	Case	TMU	DESCRIPTION
AP1	16.2	With Regrasp	AP2	10.6	Without Regrasp

METHODS-TIME MEASUREMENT APPLICATION DATA IN T M U

1 TMU = .00001 hour
= .0006 minute
= .036 second

METRIC CARD

Do not attempt to use this chart or apply Methods-Time Measurement in any way unless you understand the proper application of the data. This statement is included as a word of caution to prevent difficulties resulting from misapplication of the data.

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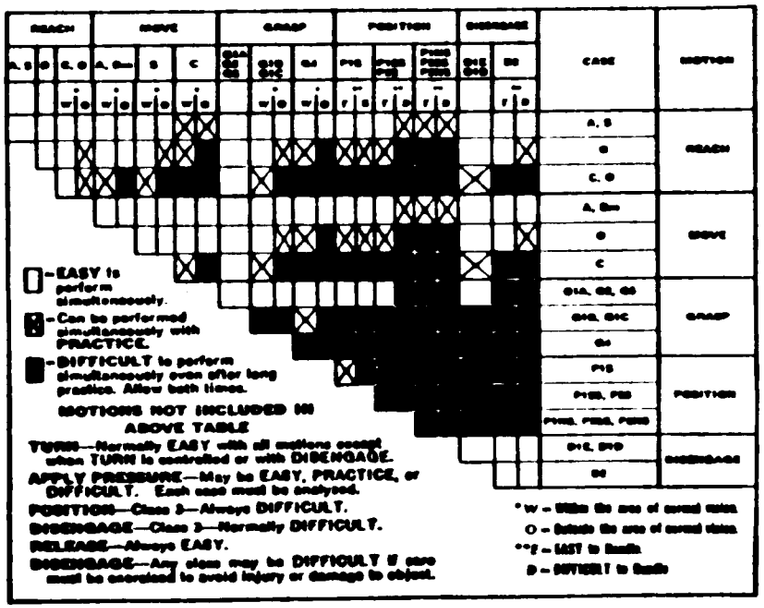
BODY, LEG AND FOOT MOTIONS

DESCRIPTION	SYMBOL	DISTANCE	TIME TMU
Foot Motion Hinged at Ankle	FM	Up to 10 cm	8.5
With heavy pressure	FMP		19.1
Leg or Foreleg Motion.	LM	Up to 15 cm	7.1
		Each add'l. cm	.5
Sidestep- Case 1- Complete when leading leg contacts floor.	SS-C1	Less than 30 cm	Use REACH or MOVE Time
		30 cm	17.0
Case 2- Lagging leg must contact floor before next motion can be made.	SS-C2	Each add'l. cm	.2
		30 cm	34.1
		Each add'l. cm	.4
Bend, Stoop, or Kneel on One Knee. Arise	B,S,KOK		29.0
	AB,AS,AKOK		31.8
Kneel on Floor - Both Knees.	K@K		69.4
Arise.	AK@K		76.7
Sit.	SIT		34.7
Stand from Sitting Position.	STD		43.4
Turn Body 45 to 90 degrees-			
Case 1- Complete when leading leg Contacts floor.	TBC1		18.6
Case 2- Lagging leg must contact floor before next motion can be made	TBC2		37.2
Walk.	W-M	Per Meter	17.4
Walk	W-P	Per Pace	15.0
Walk Obstructed	W-PO	Per Pace	17.0

SIMULTANEOUS MOTIONS



TURN-T

Time TMU for Degrees Turned											Weight in kg
30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°	
2,8	3,5	4,1	4,8	5,4	6,1	6,8	7,4	8,1	8,7	9,4	Small - 0 - 1
4,4	5,5	6,5	7,5	8,5	9,6	10,6	11,6	12,7	13,7	14,8	Medium - 1,1 - 5
8,4	10,5	12,3	14,4	16,2	18,3	20,4	22,2	24,3	26,1	28,2	Large - 5,1 - 16

GRASP-G

Case	TMU	DESCRIPTION	
G1A	2,0	Pick Up Grasp -Small, medium or large object by itself, easily grasped.	
G1B	3,5	Very small object or object lying close against a flat surface.	
G1C1	7,3	> 12 mm Ø	Interference with grasp on bottom and one side of nearly cylindrical object.
G1C2	8,7	6 to 12 mm Ø	
G1C3	10,8	< 6 mm Ø	
G2	5,6	Regrasp.	
G3	5,6	Transfer Grasp.	
G4A	7,3	> 25 x 25 x 25 mm	Object jumbled with other objects so search and select occur.
G4B	9,1	6 x 6 x 3 - 25 x 25 x 25 mm	
G4C	12,9	< 6 x 6 x 3 mm	
G5	0	Contact, sliding or hook grasp.	

RELEASE-RL

Case	TMU	DESCRIPTION	Case	TMU	DESCRIPTION
RL1	2,0	Normal release performed by opening fingers as independent motion.	RL2	0	Contact Release

POSITION-P

Distance moved to engage-25mm or less.

CLASS of FIT		DESCRIPTION	Symmetry	EASY TO HANDLE	DIFFICULT TO HANDLE
P1	Loose	No pressure required	S	5,6	11,2
			SS	9,1	14,7
			NS	10,4	16,0
P2	Close	Light pressure required	S	16,2	21,8
			SS	19,7	25,3
			NS	21,0	26,6
P3	Exact	Heavy pressure required.	S	43,0	48,6
			SS	46,5	52,1
			NS	47,8	53,4

DISENGAGE-D

CLASS OF FIT			Easy to Handle	Difficult to Handle
D1	Loose	Very slight effort, blends with subsequent move.	4,0	5,7
D2	Close	Normal effort, slight recoil.	7,5	11,8
D3	Tight	Considerable effort, hand recoils markedly.	22,9	34,7

EYE TRAVEL-ET

Eye Travel Time = $15.2 \times \frac{T}{D}$ TMU, with a maximum value of 20 TMU.

where T = the distance between points from and to which the eye travels.

D = the perpendicular distance from the eye to the line of travel T.

EYE FOCUS-EF

Eye Focus Time = 7.3 TMU.

D. Relation to Time Study Elements

Time and Motion Study engineers generally agree that elements of .02 to .03 minutes are minimum practical.

MTM elements of .0006 minutes can be studied.

There are 16.7 TMU per .01 minute.

There are 27.8 TMU per second.

E. Basic Motions (Emphasize Industrial)

MTM classifies Body, Hand, Arm, Finger, Eye, Foot, and Leg motions and combinations thereof. Except in rare instances, these are adequate to cover industrial operations.

Were not intended to measure a high jumper performing a "western roll", 100-meter dash, and the like.

F. Description of MTM Motions and Symbols

1. Reach

To get fingers or hand to a location.

Symbol - R26B

R - Reach

26 - 26cm

B - To object in approximate location

Example: Reach to pencil on table.

F. Description of MTM Motions and Symbols (cont'd)

2. Hand In Motion Reach (Brief discussion, no detail)

Hand, like motion itself, must be started and stopped.

Three types of Hand In Motion Reaches:

Type I - Hand not moving at beginning or end of Reach.

Type II - Hand is moving at beginning or end of Reach.

Type III - Hand is moving at both beginning and end of Reach.

Type I - R26B or standard Case B Reach.

Type II - mR26B or R26Bm

Type III - mR26Bm

3. Move

To transport an object with the hand.

Symbol - M26B

M - Move

26 - 26cm

B - To an approximate location

Example: Move pencil 26cm.

4. Hand In Motion Move

Three types - same as for Reach.

mM26B or M26Bm

mM26Bm

F. Description of MTM Motions and Symbols (cont'd)

5. Grasp

To gain control of an object with fingers or hand.

Symbols - G5, G1A, G2, G3, etc.

Give examples.

6. Release

To relinquish control by opening fingers.

Symbol - RL1, RL2

Example: RL1 - drop pencil.

Now a complete motion pattern: Reach to pencil, Pick it up, Move it, Release it - R26B, G1A, M26B, RL1.

7. Turn

Either rotating the hand or an object about the axis of the forearm.

Symbols - T90S, T90M, T90L

T - Turn

90 - 90 degree rotation about axis

S, M, L - small, medium, large

Examples: Opening valves, turning hand over.

8. Apply Pressure

The exertion of additional force.

Symbol - AP1 or AP2

AP1 - Apply Pressure Case 1

F. Description of MTM Motions and Symbols

8. Apply Pressure (cont'd)

AP2 - Apply Pressure Case 2

Examples: Pushing button where hesitation is noticeable; exerting force against wall as if to move it.

9. Position

To bring objects together in some predetermined and near exact relationship.

Symbols - P1SE, P2SSE, P3NSD

P - Position or align

1, 2, or 3 - Class of fit

S, SS, NS - Symmetry

E or D - Easy or Hard to handle

Examples: P1SE, putting cap on fountain pen; pencil to point on paper; locating part in die.

10. Disengage

To break contact on separate parts where hand recoils.

Symbols - D1E, D2D, D3D

D - Disengage

1, 2, or 3 - Class of fit

E or D - Easy or Hard to handle

Examples: Cap from fountain pen; cork out of bottle; breaking force after releasing toggle clamp.

F. Description of MTM Motions and Symbols (cont'd)

11. Eye Travel

The movement of eyes from point to another. Does not include inspection between points.

Symbol - ET 40/46

ET - Eye Travel

40cm - Distance eye travels

46cm - Perpendicular distance to line of travel

Example: Looking from one coin to another on table.

12. Eye Focus

The act of pausing as the eyes take in an area under surveillance or make a simple decision.

Symbol - EF, Eye Focus

Example: In example of coins, EF occurs when eye stops to determine the denomination.

13. Foot Motion

Motion of foot hinged at the ankle - up to 10cm.

Symbols - FM and FMP

FM - Foot Motion

FMP - Foot Motion with Pressure

Examples: Stepping on walnut (FM) and stepping on walnut as if to break it (FMP).

F. Description of MTM Motions and Symbols (cont'd)

14. Leg Motion

Motion of leg hinged at hip and/or knee.

Symbol - LM15

LM - Leg Motion

15 - 15cm travel of knee or ankle

Example: Operating a kick press.

15. Side Step

The sideways movement of the body by moving one or both feet.

Symbol - SS30C1 or SS30C2

SSC1 - Side step Case 1

SSC2 - Side step Case 2

30 - Distance body moves in cm.

Examples: Shifting body to get around table; moving between 2 drill presses side by side.

16. Bend and Arise

Upper body movement hinged at the waist - destination of hands to vicinity of the knees.

Symbols - B, AB

Example: Get eraser from chair and stand erect.

F. Description of MTM Motions and Symbols (cont'd)

17. Stoop and Arise

Upper body movement hinged at waist - destination of hands to vicinity of floor.

Symbols - S, AS

Example: Get eraser from floor and stand erect.

18. Kneel and Arise

Body movement from erect standing position to position with either one or both knees on floor.

Symbols - KOK, KBK, AKOK, AKBK

Examples: KOK, AKOK - get letter from bottom file drawer; KBK, AKBK - kneel with knees touching floor independently, not simultaneously, and return to standing erect.

19. Sit and Stand

To sit from standing position, in chair, approximately 45cm to 50cm in height.

Includes no motions for moving or adjusting the chair.

Symbols - SIT, STD

Example: Sit and Stand with arms folded.

20. Turn Body

Rotation of shoulders - 45 to 90 degrees.

Usually effected by movement of one or both feet.

Symbols - TBC1, TBC2

Example: Turn from class to board.

F. Description of MTM Motions and Symbols (cont'd)

21. Walk

Disregard per foot method

85cm stride seldom encountered in industrial walking

1 Pace is same as moving one foot from rear to front of body after body is in motion.

Symbol - W3P, Walk 3 Paces

Example: Normal, straight walking.

G. MTM Element Analysis

MOTION PATTERN _____

Pipe Union Assembly

Description-Left Hand	✓	Class	Time	Class	✓	Description-Right Hand
aside assembled parts		M20B	12.9	R25C		to nut
		RL1	7.3	G4A		nut
toward swivels		R15B	12.2	M25B		to work area
				~~G2~~		preposition
		R5C	5.9	RL1		
a swivel		G4A	7.3			
to nut		M25C	13.5	R20B		
		~~G2~~				
into nut		P2SE	16.2			
to secure control		G2	5.6			
nut up on swivel		M3C	3.4			
			5.9	R5C		to bushing
			7.3	G4A		bushing
			13.5	M25C		to nut and swivel
				~~G2~~		
			16.2	P2SE		into nut and swivel
			2.9	M3B		back to engage threads
			11.6	M3B	4	
			6.0	RL1	3	
			7.5	R1A	3	screw down
			6.0	G1A	3	
			16.2	AP1		final tighten
			2.0	RL1		
			179.4	TMU		
		equals	.108	minutes		
+ 15% PFD		equals	.124	minutes		

H. Problem Sheet for Symbols, Time, and Methods Description

What are the Symbols and Time in TMU for the following Motions?

	Motion Description	Symbol	Time - TMU
1.	Reach 30cm to a single part in a location which may vary slightly from cycle to cycle.	R30B	12.8
2.	Grasp an object jumbled with other objects (12mm x 12mm x 12mm).	G4B	9.1
3.	Move hand 45cm when tossing light objects aside. (Hand in motion at end of move.)	M45Bm	14.0
4.	Turn 11-kg object 90 degrees.	T90L	16.2
5.	Position a semi-symmetrical, easy to handle part where a close fit is encountered.	P2SSE	19.7
6.	Disengage a difficult to handle part from a tight fit.	D3D	34.7
7.	Release part by opening fingers as independent motion.	RL1	2.0
8.	Move leg 30cm.	LM30	14.3
9.	Sit down.	SIT	34.7

H. Problem Sheet for Symbols, Time, and Methods Description (cont'd)

Describe the Motions represented by the following Symbols and record the Time in TMU required to make them.

	Symbol	Motion Description	Time - TMU
1.	R15C	Extend the hand to an object jumbled among others requiring search and select.	10.1
2.	M45Bm	Carry an object to point of releasing hand, continuing on after release.	14.0
3.	T30S	Rotate a light object 30 degrees by twisting the wrist.	2.8
4.	G1C2	Get control of a cylindrical object in orderly row. Size 6mm-12mm diameter.	8.7
5.	P1NSD	Insert difficult to handle object into another in a loose fit and nonsymmetrical relationship.	16.0
6.	D1D	Separate two loose fitting objects when one is difficult to handle.	5.7
7.	RL2	Give up control of an object by breaking finger or hand contact.	-0-
8.	SS50C2	Shift body 50cm to the side using both feet.	42.9
9.	TBC1	Rotate body 45-90 degrees by moving one foot to side and rear.	18.6

H. Problem Sheet for Symbols, Time, and Methods Description (cont'd)

The first element of a certain assembly operation is "Get part and Move to assembly position." The element is performed entirely with the right hand. Starting from a point close to the front of his body, the operator reaches 25cm for a light part which is by itself on the workbench in a location which may vary slightly from time to time. He grasps it with a "pick-up grasp" on an object by itself in an easy grasping position and moves it 15cm to an approximate location. He releases it with a normal release performed by opening the fingers as an independent motion and returns his hand 25cm to an indefinite location near his body. Express the 5 motions employed in terms of Methods-Time Measurement Symbols and determine the Time in TMU for each Motion. What is the Time for performing the element in TMU? In decimal hours? In seconds? In decimal minutes?

	Symbol	Time - TMU
1.	R25B	11.5
2.	G1A	2.0
3.	M15B	8.9
4.	RL1	2.0
5.	R25E	10.5
	Total Time - TMU	34.9

Dec. Hours .000349 Dec. Minutes .02094 Seconds 1.2564

I. Uses and Limitations of MTM and Time and Motion Study

1. Principal Uses of MTM

a. Developing effective methods in advance of production.

b. Developing time formulas.

(1) Smaller elemental breakdown.

(2) Greater flexibility of elements.

(3) Exact conditions of application are recorded.

c. Estimating.

(1) More lengthy than "comparison method" used by most estimators but more accurate.

(2) Need only to visualize operation well to establish time.

(3) Permits best choice of method of operation.

d. Guiding product design. Designing products for most economical production methods.

e. Developing effective tools.

(1) Choice of ways of tooling.

(2) Determination of handling and set-up times.

(3) Design based on function as well as cost of labor to use.

f. Selecting effective equipment.

(1) Same consideration as for effective tooling.

(2) Recommend location of buttons, handles, switches, etc., best suitable from an operator's or user's point of view.

I. Uses and Limitations of MTM and Time and Motion Study

1. Principal Uses of MTM (cont'd)

g. Training operators and supervisors to become methods conscious.

(1) Selection of best teachable method.

(2) Teach proper motion pattern at the start, thus reducing chances of developing bad habits.

(3) Eliminate excessive motions due to habit.

(4) Teach best layout and best place to "get parts and aside parts".

(5) Provide a detailed motion by motion analysis of the operation for:

Operator

Set-Up Man

Supervisor.

h. Settling grievances.

(1) Time and Motion are one value for all like operations.

(2) Helps solve reasons for high and low make-outs.

(3) Permits a common language--method not time.

(4) Permits a detailed historical record of the approved method to avoid argument and discussion over conditions in effect at time standard was set.

I. Uses and Limitations of MTM and Time and Motion Study (cont'd)

2. Limitations of MTM

a. Pure process time. (Better suited to Time and Motion Study.)

b. Machine controlled times, where effort of operator is of no influence.

(1) Automatic feed control on lathe.

(2) Jolting time while machine moulding.

(3) Flight of object tossed from one hand to the other.

(4) Cutting time on any automatic machine tool.

(5) The stroke of a punch press.

(6) Automatic return on outfeed end of a machine.

c. Combination process and manual time. (Better suited to Time and Motion Study.)

Frequently operations are encountered in which a machine or process influences or slows down the rate at which manual motions are normally performed, such as:

(1) Buffing, polishing, coloring.

(2) Sanding and finishing on wood and other surfaces.

(3) Routing.

(4) Trim operation in brush painting.

(5) Carrying brimful container of liquid.

d. Mental or safety controlled time.

This kind of operation is not readily measurable by either MTM or Time and Motion Study.

I. Uses and Limitations of MTM and Time and Motion Study

2. Limitations of MTM

d. Mental or safety controlled time. (cont'd)

Examples:

(1) Drafting.

(2) Tool design or layout.

(3) Servicing high voltage equipment.

(4) Handling dangerous chemicals.

(5) Reading and studying highly technical material.

J. Principal Uses of Time and Motion Study

The principal uses of Time and Motion Study have been indicated under "Limitations of MTM".

General uses are:

1. To establish process or process controlled times.
2. To establish feeds, speeds, RPM, etc.
3. Check MTM values.
4. Check times where little or no hand or body motions are present.
5. Provides a relatively quick means of establishing an individual time standard.
6. It is often desirable to set standards where methods are poor and time is limited for methods study and correction.
7. To set standards on unpredictable or nonrecurring operations.

Examples:

a. Operations of infrequent and long cycle, such as:

b. Erecting a special scaffolding.

J. Principal Uses of Time and Motion Study (cont'd)

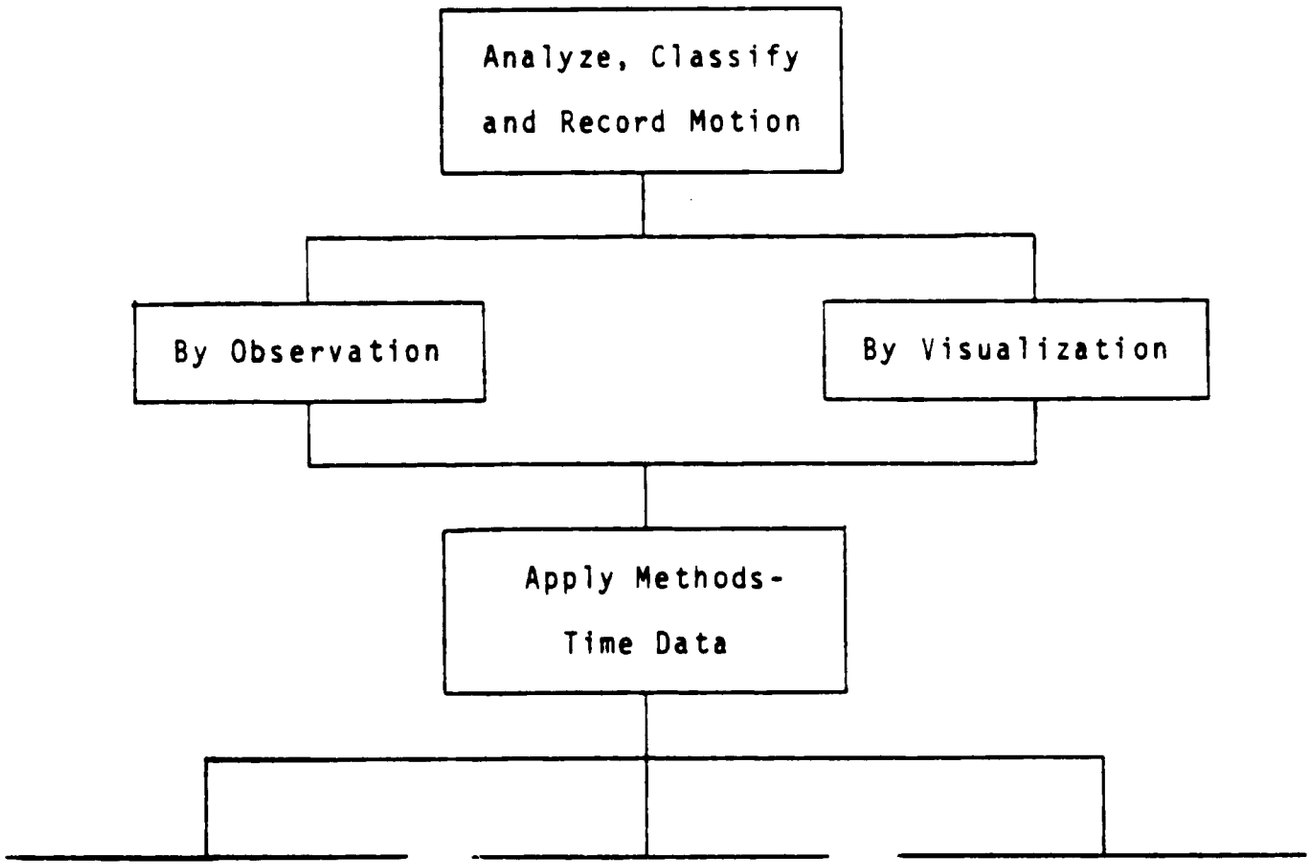
7. c. Preparing a pit for pit moulding.

d. Corralling livestock for slaughter in a packing house.

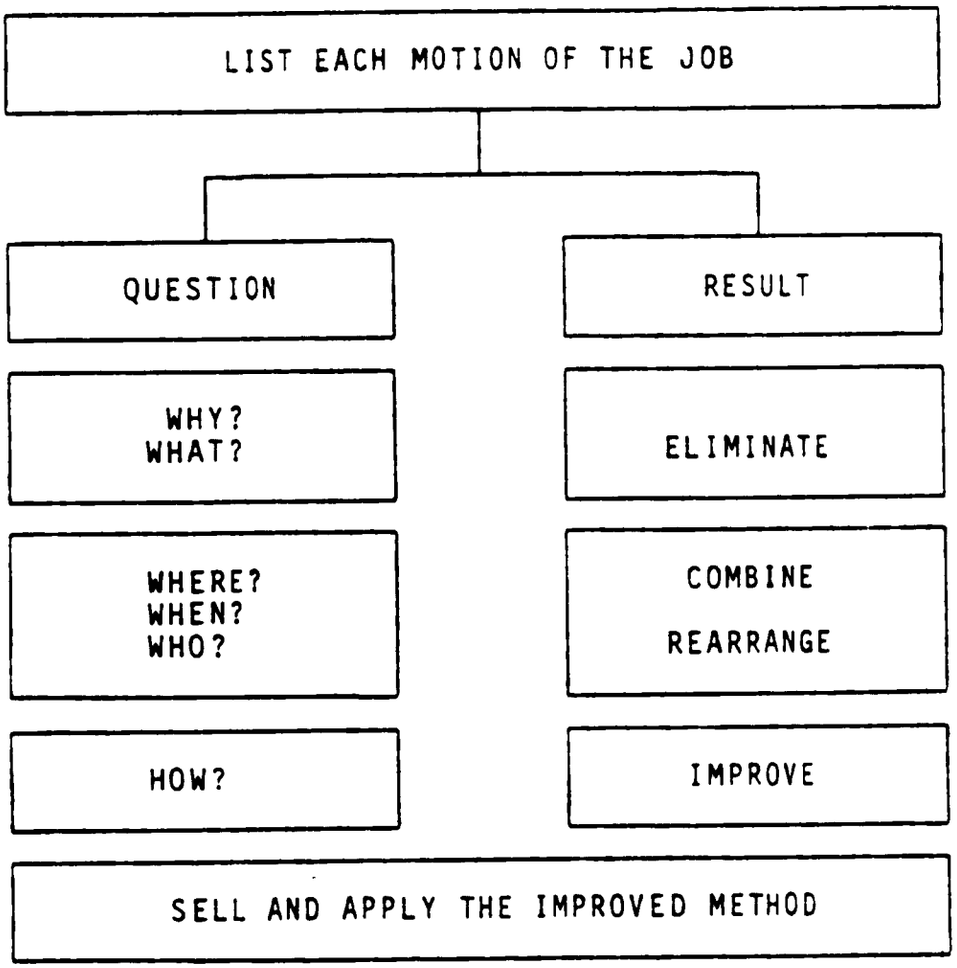
K. Advantages of MTM Over Time and Motion Study

1. Leveling eliminated.
2. Human factor of being timed--"Not consulted on way of doing job", just time taken.
3. Operation studied--not operator.
4. Skill of operator not too important.
5. Industrial normal or leveled time (MTM values).

L. Outline of Procedure



M. Job Improvement Procedure with MTM



MOTION ECONOMY RELATED TO THE HUMAN BODY

1. The hands should be idle a minimum amount of time.
2. Motions should be confined to the lowest order possible.
3. Changes in direction should be kept to a minimum.
4. Reduce fatigue to a minimum.
5. Arm motion paths should be simultaneous, symmetrical, and if possible in opposing directions.
6. Both hands should not be idle at the same instant.
7. Basic motions should begin and end at the same instant.
8. Momentum should be employed to assist operators where possible and reduced to a minimum when muscular action must check an object having momentum.
9. Eliminate controlled movements whenever possible.
10. Motion sequence should promote automaticity.
11. Hands should be relieved of any work that can be performed by other body members.

VI. SIMPLIFIED PREDETERMINED TIMES (BASIC STANDARD DATA)

Essentially the same procedure as MTM. The technique has been simplified, and analysis time reduced, by taking advantage of averaging, and compensating variations. (See BSD Data Card.)

A. How Derived - Purpose

A series of motions usually appear to be complicated and undirected.

Basically, operator uses hands and arms to:

1. Get something.
2. Place it somewhere else.

To simplify further, there are:

1. Two ways to pick things up.
2. Three places to put them.

(Refer to "Get" and "Place" sections of BSD Data Card.)

Once an operator "Gets" something (lever, push button, hand tool, gauge, etc.), there are 8 choices of action he may follow:

1. Get something else.
2. Put it somewhere else.
3. Rotate it (about axis of forearm) without first placing it somewhere else.
4. Use it ("Back and Forth") without first placing it somewhere else.
5. Place it somewhere else and rotate it.

A. How Derived - Purpose (cont'd)

6. Place it somewhere else and use it.

7. Place it somewhere else, rotate it, and put it away.

8. Place it somewhere else, use it, and put it away.

In most instances, BSD forces the analyst into a "yes" or "no" decision. Something is this or that.

Conventional predetermined motion times systems often provide an analyst with a dozen choices for classifying one motion.

This is the inherent drawback to the conventional systems.

BSD reduces analysis time by as much as 50% over the conventional systems.

B. Description of BSD Motions and Symbols

1. Get

Symbol - G

Variables:

a. Number of objects

One or two--one or both hands used.

b. Degree of control

(1) Easy--control is obtained by contact or simple closing of fingers on the object.

(2) Difficult--additional grasping motions must be used before sufficient control is obtained.

B. Description of BSD Motions and Symbols (cont'd)

2. Place

Symbol - P

Variables:

a. Number of locations

One or two--one or both hands used.

b. Destination

(1) To general location; no eye control.

(2) To other hand.

(3) To "loose" location; some visual control is required.

(4) To "close" location; continued visual control is required.

c. Distance

Distance traveled by the hand (less body assistance).

3. Distance Factors - Get and Place

	Standing	Seated
Direction	Net Distance	
Straight ahead	15cm	30cm
45 Degrees to side	30cm	45cm
90 Degrees to side	45cm	45cm*

* Almost always assisted by body shift to reduce net displacement by about 15cm.

B. Description of BSD Motions and Symbols (cont'd)

4. Apply Pressure

Symbol - AP

Variables do not apply.

a. Requires mental control.

b. Characterized by noticeable hesitation.

c. No other controlled motion can accompany.

5. Regrasp

Symbol - RG

a. Requires visual control when allowable.

b. Characterized by noticeable hesitation.

c. No controlled motion can accompany.

6. Body Motions

Symbols:

FM - Foot Motion. Hinged at ankle as in actuating pedal.

SM - Stepping Motion. Count each time foot touches floor any direction, any motion of leg.

BAB - Bend And Arise From Bend. Bend to position, hand to knee or below, and arise afterward.

SAS - Sit And Stand. Sit down and stand up, including motions to move chair.

B. Description of BSD Motions and Symbols (cont'd)

7. Rotate

Symbol - RO

Variable:

Type - F. Turn with motion of thumb and forefinger. Fingers may not stop with each repetition as control of the object is regained.

W. Turn where heavy resistance is encountered. Fingers only grasp and release object. Turn is accomplished by torsional motion of wrist and forearm.

C10. Turn where hand makes circular motion about 10cm in diameter. Turn hand wheels, wrap string, etc. Elbow acts as pivot.

C20. Turn where hand makes circular motion about 20cm in diameter. Elbow acts as pivot.

8. Back and Forth

Symbol - B-F

Variable:

Type - f. Very light flicking motion of the finger or light tapping or brushing. Distances moved less than 2cm.

5. Moderate tapping or brushing on narrow surface. Motion covers distance of about 5cm.

B. Description of BSD Motions and Symbols

8. Back and Forth (cont'd)

Type -10. Sharp tapping or wiping small area with cloth. Sanding out blemish or bumping heavy object with heel of hand. Displacement about 10cm.

15. Striking heavily with hammer, wiping large area, or area sanding. Hand or wrist moves 15cm although combined displacement may be much more.

9. Eye Motions

Symbols:

EF - Eye Focus. Within area of normal vision, eyes must search out and focus on object long enough to distinguish it.

ET - Eye Travel. The basic eye action employed to shift the aim of the axis of vision to a new viewing area.

10. Explanation of BSD Symbols

Motion	Symbol	Distance, Frequency	Fit, Control, Type	Hands Used
Get	G	30cm	E	2
Place	P	45cm	G	2
Rotate	RO	8	f	2
Back & Forth	B-F	4	4	1

Explanation

G12E2 - Get two easily grasped objects 30cm away.

P18G2 - Move two objects to a general location 45cm away.

RO8f2 - Rotate objects simultaneously 8 cycles.

B4F4 - Move single object back and forth 4 times.

C. Limitations of Basic Standard Data

1. Accuracy

BSD can be compared for accuracy in three ways:

a. With leveled time study.

b. With conventional standard data based on MTM.

c. With detailed MTM analysis.

Factors to consider are:

a. Comparisons are based on same method.

b. Both systems anticipate the same performance levels.

c. The same allowances are used.

d. The same conditions prevail.

When these four factors prevail, BSD has proven accurate to within plus or minus 5% in hundreds of independent studies.

The greatest variations in existing data occur in very short cycle operations. In this instance, "very short cycle" is interpreted to mean operations of 10 seconds or less in duration.

2. Exercise (Refer to pass-out on Pipe Union Assembly.)

Fill in description, symbols, and values on the BSD Analysis Sheet.

Exercise illustrates:

a. Reduced analysis time compared to MTM.

b. How accuracy begins to be affected on very short cycle operations. Point out the fact that the 25cm Reaches and Moves do not have a chance to "average out" in this

C. Limitations of Basic Standard Data

2. Exercise (cont'd)

kind of operation. The BSD Data Card is set up on 5, 15, 30, and 45cm hand and arm movements.

In the Pipe Union Assembly, the BSD data is somewhat "loose" in comparison to the MTM data. This is the result of using 30cm Get and Place movements as opposed to 25cm Reach and Move movements.

The Exercise may also be used for test purposes.

BSD ANALYSIS SHEET

Page____of____

PART NO. PART NAME DATE

OPER. NO. OPER. NAME Pipe Union Assembly

MACH. NO. MACH. NAME

DESCRIPTION	CODE	TMU	F	TOTAL
Get nut from tote pan	G30D1	25	1	25
Place nut into position	P30L1	21	1	21
Get swivel from tote pan	G5D1	17	1	17
Place swivel into nut	P30C1	31	1	31
Control nut and swivel	RG	6	1	6
Nut up on swivel	RO1F	9	1	9
Get bushing from tote pan	G5D1	17	1	17
Place bushing into nut and swivel	P30C1	31	1	31
Screw down assembly	RO4F	38	1	38
Final tighten	AP	11	1	11
		TOTAL		206
		TOTAL WITH 15 % ALLOWANCE		237
		TOTAL MINUTES		.1421

VII. THE IMPACT OF WORK MEASUREMENT ON THE ORGANIZATION

No attempt is made to separate benefits that accrue specifically to Time and Motion Study or Predetermined Times.

The instructor will readily recognize them in the following material.

A. For the Worker

1. Increases job security.

   Methods changes are minimized; more methods work can be done in advance of production.

   The job analysis used as a basis for incentive standards (as well as possibly forming part of the basis for job and/or merit rating) is based on facts which are relatively noncontroversial.

   No subjective rating enters into job analysis. A factual record of changes over a period of time is available.

2. Equivalent pay for equivalent effort.

   All times are taken from the same source; there is no individual rating of each job.

   It is generally easier to demonstrate to the worker that allowance has been made for each motion he must perform.

3. Inclusion.

   The pace of the worker is relatively unimportant; once the worker realizes this, the tension which naturally results from being timed will be eliminated.

A. For the Worker

3. Inclusion. (cont'd)

The worker can offer information helpful in developing the work measurement analysis. This information may make a real contribution to the study.

Even if it cannot be used because the worker is misinformed on some job detail, it gives the worker a chance to participate in the analysis.

Because of this inclusion, standards will tend to be more readily accepted.

Jobs can be learned faster--by using operator training charts based on work measurement analysis; the worker can earn bonus sooner.

B. For Management

1. Standards are more consistent.

Grievances over rates will be less frequent.

Earnings will be more homogeneous--less "running away" with rates.

2. Wider coverage of operations will be possible.

Because standard data can be developed faster, it is practical to cover operations not covered before.

Standard data can be developed for operations requiring extremely detailed breakdown of constants and variables.

B. For Management (cont'd)

3. Better analysis tool.

More methods improvements.

Better tool and product design.

Better evaluation of equipment for purchase.

Better estimating work.

4. Less learning time allowance

Save money.

Achieve greater operator flexibility.

5. Better wage incentive administration.

Factual basis for deciding if a rate change is warranted for small job changes.

Factual basis for settling rate grievances.

BASIC STANDARD DATA

GET — G			
Dist. CM	Easy 1 - 2	Difficult 1	Difficult 3
5	8	17	30
15	13	21	34
30	17	25	38
45	21	30	42

Body Motions	
BAB	61
SAS	174
SM	17
FM	9

Regrasp	
RG	6

Apply Pressure	
AP	11

PLACE — P						
Dist CM	Other Hand	Gen.	Loose 1	Loose 3	Close 1	Close 3
5	7	5	11	26	21	47
15	11	9	16	31	27	52
30	15	13	21	36	31	57
45	19	17	26	41	37	62

Eye Motions	
EF	7
ET	2/5CM

ROTATE — RO										
Type	1	2	3	4	5	6	7	8	9	10
F	9	19	28	38	47	56	66	75	85	94
W	15	30	44	59	74	89	104	118	133	148
C1	17	28	39	51	62	74	85	96	108	119
C2	19	32	46	60	73	87	100	114	128	141

BACK & FORTH B-F										
Dist CM	1	2	3	4	5	6	7	8	9	10
f	4	8	12	16	20	24	28	32	36	40
5	8	16	25	33	41	49	57	66	74	82
10	13	26	39	52	65	78	91	104	117	130
15	17	34	51	68	85	102	119	136	153	170

1. Get And Aside Tools
2. Get Parts/Material
3. Place Parts/Material
4. Use Tools - Medium Control
5. Use Tools - High Control
6. Process Parts/Material w/Hands
7. Activate Machines
8. Machine Time
9. Aside Parts/Material
10. Inspect

VIII. DEVELOPMENT OF STANDARD DATA USING MTM

A. Show and explain sample of Motion Pattern which describes a basic job element.

B. Show sample of Index to Motion Patterns--arranged by type of component or body motion.

D. Show and explain Formula Sheet.

E. Show and explain Application Sheet.

(MOTION PATTERN)

METHODS ANALYSIS SHEET

REFERENCE NO. CV 20

PART _____ DATE _____ STUDY NO. _____

OPERATION FOLD COVER - ONE HAND ANALYST _____ SHEET NO. _____ OF _____ SHEETS

DESCRIPTION-LEFT HAND	NO	LH	TMU	RH	NO	DESCRIPTION-RIGHT HAND
To Cover		R15B	8.6			
Cover		G5	0			
Cover		G1B	3.5			
Fold		M8B	5.7			
Release		RL1	2.0			
			—			
			19.8			

(MOTION PATTERN)

METHODS ANALYSIS SHEET

REFERENCE NO. CV 39

PART _____ DATE _____ STUDY NO. _____

OPERATION STRETCH COVER TIGHTLY ANALYST HH SHEET NO. _____ OF _____ SHEETS

DESCRIPTION-LEFT HAND	NO	LH	TMU	RH	NO	DESCRIPTION-RIGHT HAND
			8.6	R15B		Reach cover
			2.0	G1A		Grasp cover
			5.6	G2		Regrasp cover
			4.9	M8A		Move cover
			16.2	AP1		Apply pressure
			2.0	RL1		Release
			39.3			

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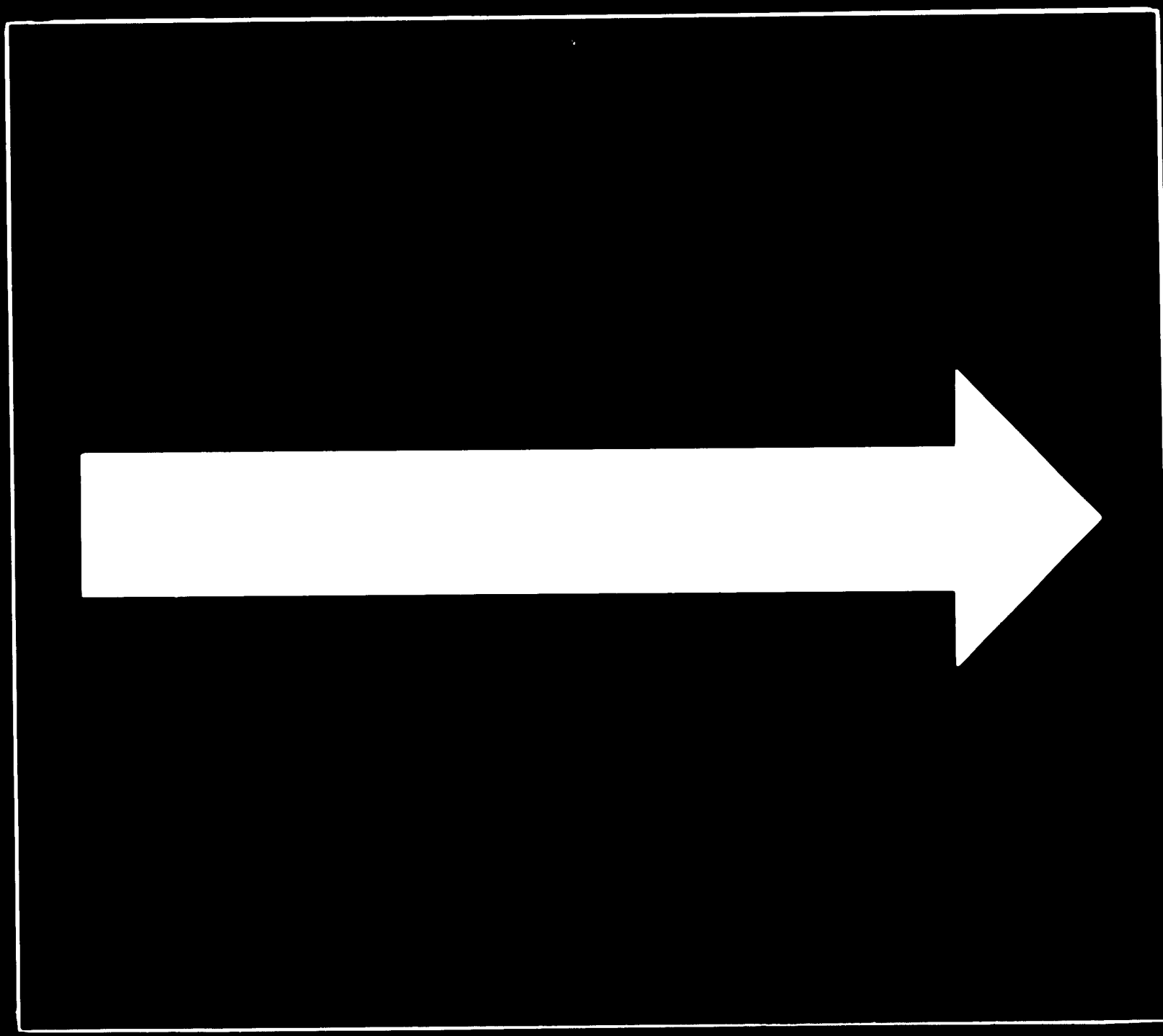

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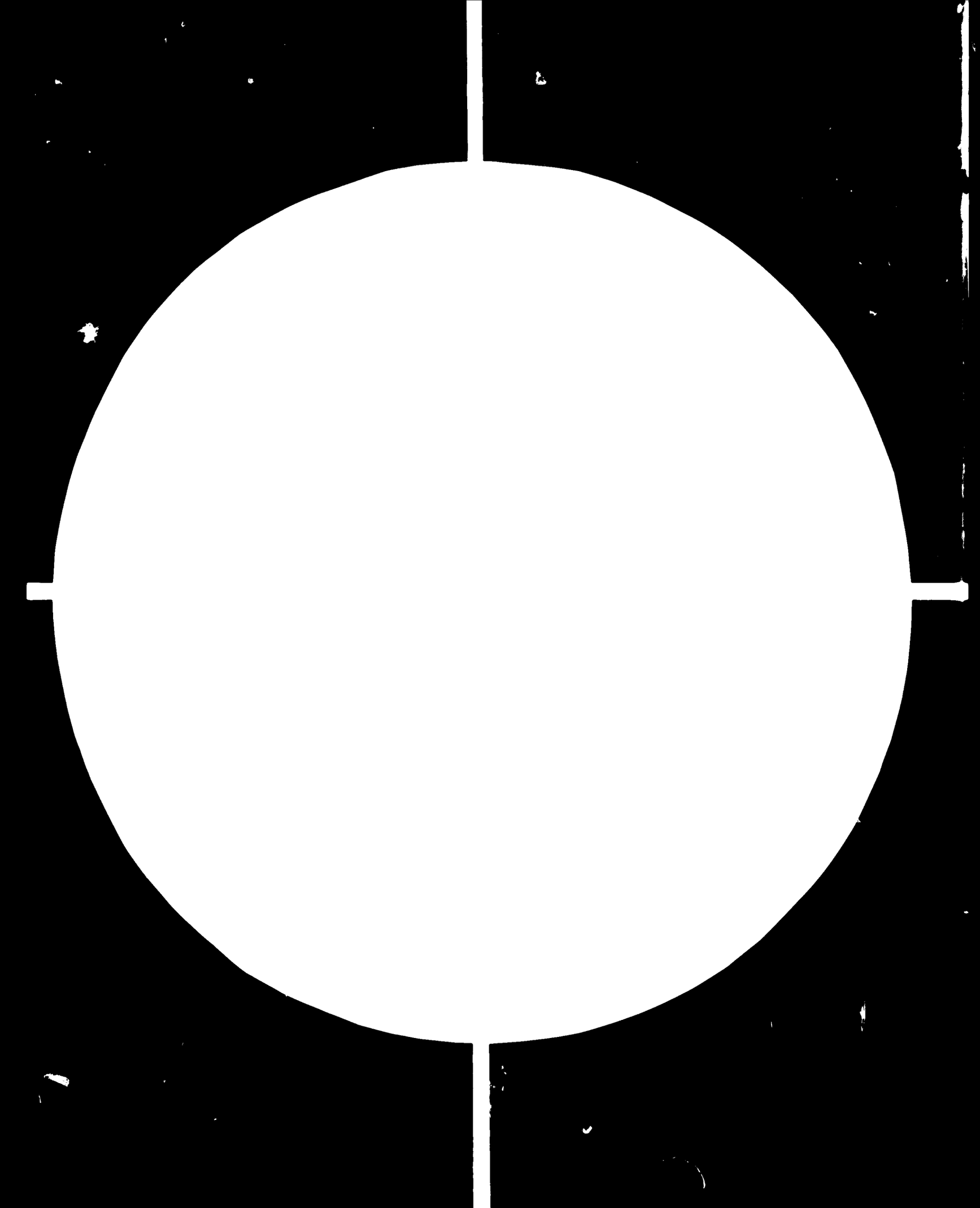

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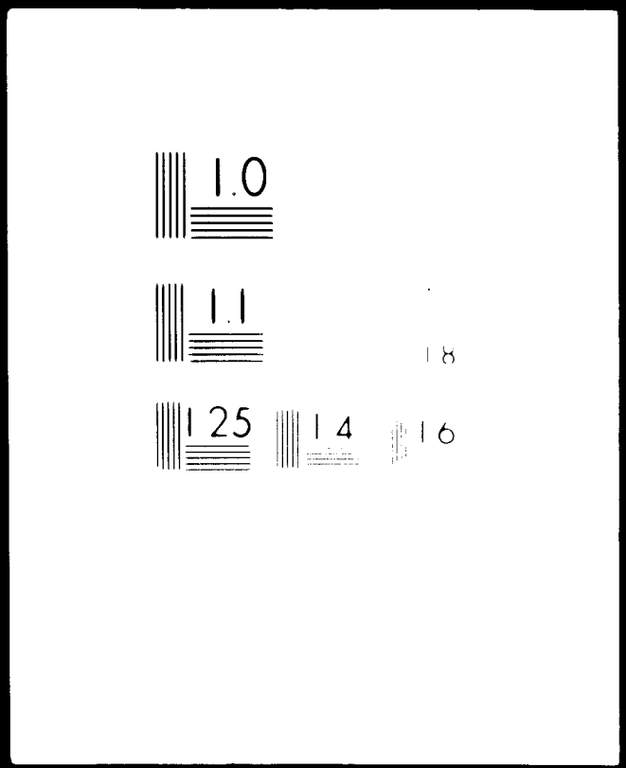

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INDEX TO MOTION PATTERNS

CV - COVER

FORMULA SHEET

DEPT. _____ REF. NO. OA CV 2522

PART _____ DATE _____

OPERATION Upholster arm - first trim ANALYST _____

STYLE 7020 type (2 arms) left open HBA+LBA SHEET 1 OF 2

CODE	DESCRIPTION	TMU	FREQ	TOTAL
BM53	Step to center of sofa	1	LTB/2	
BM104	Pick up cover from under dolly	104	1	104
BM53	Step to near arm	1	LTB/2	
HM15	Aside 2nd cover	15	1	15
BM53	Step to far arm	1	LTB	
HM15	Aside cover	15	1	15
	INTERRUPT SEQUENCE APPLY STRAPS			
	INTERRUPT SEQUENCE APPLY TF			
BM74	Step to bench and return	74	1 x 2	148
HM35	Pick up cover	35	1 x 2	70
BM74	Step to side of arm	74	1 x 2	148
HM22	Set down cover on arm	22	1 x 2	44
CV32a	Pick up cover and set down	32	1 x 2	64
CV26a	Position cover at URH corner	26	1 x 2	52
CV19	Hold cover at URH corner	19	1 x 2	38
T44	Get and aside stapler	44	1 x 2	88
ST 6/19	Staple at corner	19	2 x 2	76
BM17	Step to back of arm	17	2 x 2	68
CV39	Stretch cover to back	39	1 x 2	78
CV26a	Align cover at back	26	1 x 2	52
ST 6/19	Staple at back	19	1 x 2	38
BM17	Step to arm front	17	2 x 2	68
ST 2/14	Staple at arm top	14	$\frac{2LTA}{3}$ x 2	
CV13	Align while stapling	14	$\frac{LTA}{3}$ x 2	

FORMULA SHEET

DEPT. _____ REF. NO. OA CV 2522

PART _____ DATE _____

OPERATION Upholster arm - first trim ANALYST _____

STYLE 7020 type (2 arms) SHEET 2 OF 2
left open HBA+LBA

CODE	DESCRIPTION	TMU	FREQ	TOTAL
BM17	Step to front of arm	17	2 x 2	68
CV31	Smooth cover to base	31	1 x 2	62
BM61	Bend and arise	61	1 x 2	122
CV32a	Lift cover and set down	32	1 x 2	64
CV39	Stretch cover to base	39	1 x 2	78
T44	Get and aside stapler	44	1 x 2	88
ST 6/19	Staple at corner	19	2 x 2	76
CV26a	Align cover at center	26	2 x 2	104
ST 2/14	Staple cover at HFA	14	$\frac{HFA}{2}$ x 2	
CV20	Fold cover at URH corner	20	1 x 2	40
ST 6/19	Staple at corner	19	2 x 2	76
BM61	Bend and arise	61	1 x 2	122
CV20	Fold at base	20	1 x 2	40
ST 6/19	Staple at base	19	1 x 2	38
CV20	Fold at base	20	1 x 2	40
ST 6/19	Staple at base	19	2 x 2	76
BM17	Step to back of arm	17	2 x 2	68
CV20	Fold at back corner	20	1 x 2	40
ST 6/19	Staple at back of arm	19	1 x 2	38
CV20	Fold at back of arm	20	1 x 2	40
ST 6/19	Staple at back of arm	19	2 x 2	76
BM53	Step to far arm	1	LTB	
				2522

LTB	LTA	HFA
.5	18.7	14.0
.5	9.3	
1.0	28.0	
1.0		
3.0		

FORMULA: 2522 + 14.0 HFA + 28.0 LTA + 3.0 LTD

APPLICATION SHEET

PART Outside Arm - 7020 Type DATE 1/12/79

OPERATION Upholster Arm ANALYST NCW

STYLE 2100 SHEET 1 OF 1

REF. NO.	DESCRIPTION	TMU	FREQ	TOTAL
	Apply Cover			
OA CV 2522	Constant	2522	1	2522
	Ht. front arm	14	10	140
	Length top arm	28	24	672
	Length top back	3	75	225
	Apply Straps			
OA S 2110	Constant	1000	--	--
	Ht. front arm	19	--	--
	Length bottom arm	1	--	--
	Length top back	5	--	--
	Apply Tufflex			
OA T 1200	Constant	1200	1	1200
	Ht. front arm	24	10	240
	Length bottom arm	1	24	24

TOTAL TMU = 5023

TOTAL HOURS = .0502

STANDARD HOURS WITH 15% PF&D = .058

IX. ROUGH MILL INCENTIVE PROGRAM

A. Standard is composed of two parts:

1. Production Standard, and
2. Yield Standard.

B. Production standards are based on:

Cubic meters of wood (input) cut up at the cut-off saw per man-hour for Rough Mill group. The man-hours apply to the entire Rough Mill group--e.g., cut-off sawyers, rippers, salvage saw operators, materials handlers.

C. Yield standards are based on:

Cubic meters produced (output) at the ripsaw divided by the cubic meters cut up at the cut-off saws. This is expressed as a "percentage yield".

D. Calculation period is ten weeks. Bonus is calculated each week and is based on the last ten weeks' performance.

E. Standards are based on the average length of part cut and the average grade of lumber cut up.

F. <u>Sample Calculation</u>

1. <u>Production Bonus Calculation</u>

Man-hours on Standard for group for past 10 weeks	8,000
Standard productivity in cubic meters per hour for grade, thickness, and average length produced	.35

F. Sample Calculation

1. Production Bonus Calculation (cont'd)

Cubic meters cut up during 10-week period	3,000
Production Standard:	
Cubic meters = .35 x 8,000	2,800
Production Bonus: $\frac{3,000}{2,800}$ = 1.07 =	7%

2. Yield Bonus Calculation

Cubic meters produced at ripsaws plus salvage saw during 10-week period	1,200
Cubic meters cut up at cut-off saw during 10-week period	2,000
Percent Yield: $\frac{1,200}{2,000}$ =	60%
Standard Percent Yield based on grade, thickness, and average length cut	53%
Yield Bonus: $\frac{60\%}{53\%}$ = 1.13%	13%

3. Total Bonus

Production Bonus	+	Yield Bonus	=	Total Bonus
7%	+	13%	=	20%

F. Sample Calculation (cont'd)

All employees in the Rough Mill would then have their base rate increased, for their time on standard, by a factor of 1.20.

ROSS ASSOCIATES

UNDP/UNIDO Project for the development of the furniture and [illegible] industries and the creation of a centre UNDP/[illegible]

Annex to report by Mr. Vincent Ross on methods improvement and work measurement seminar for GOTR "Varda" outlining a proposed new mill layout with lumber lift.

SCALE

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DATE

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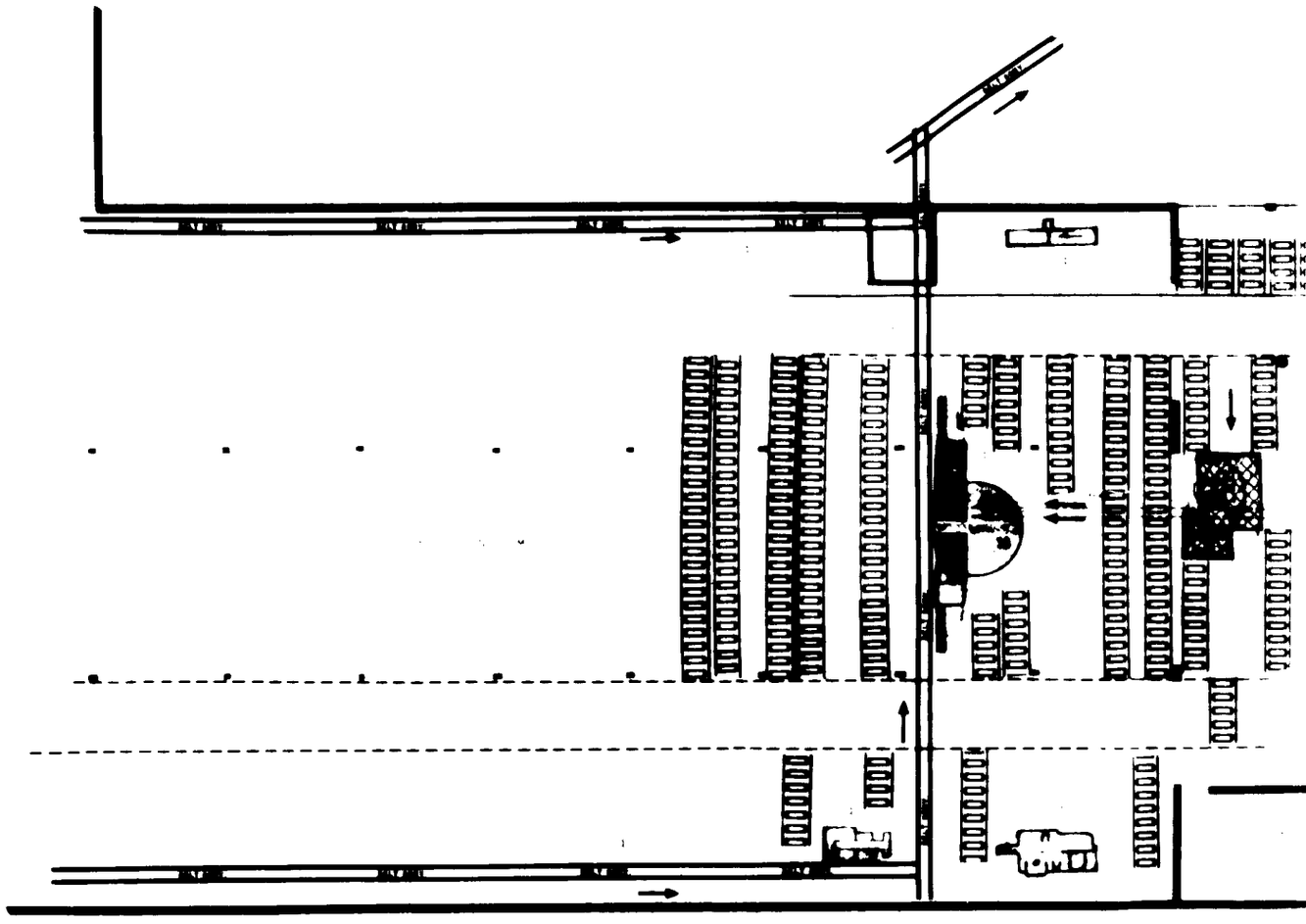

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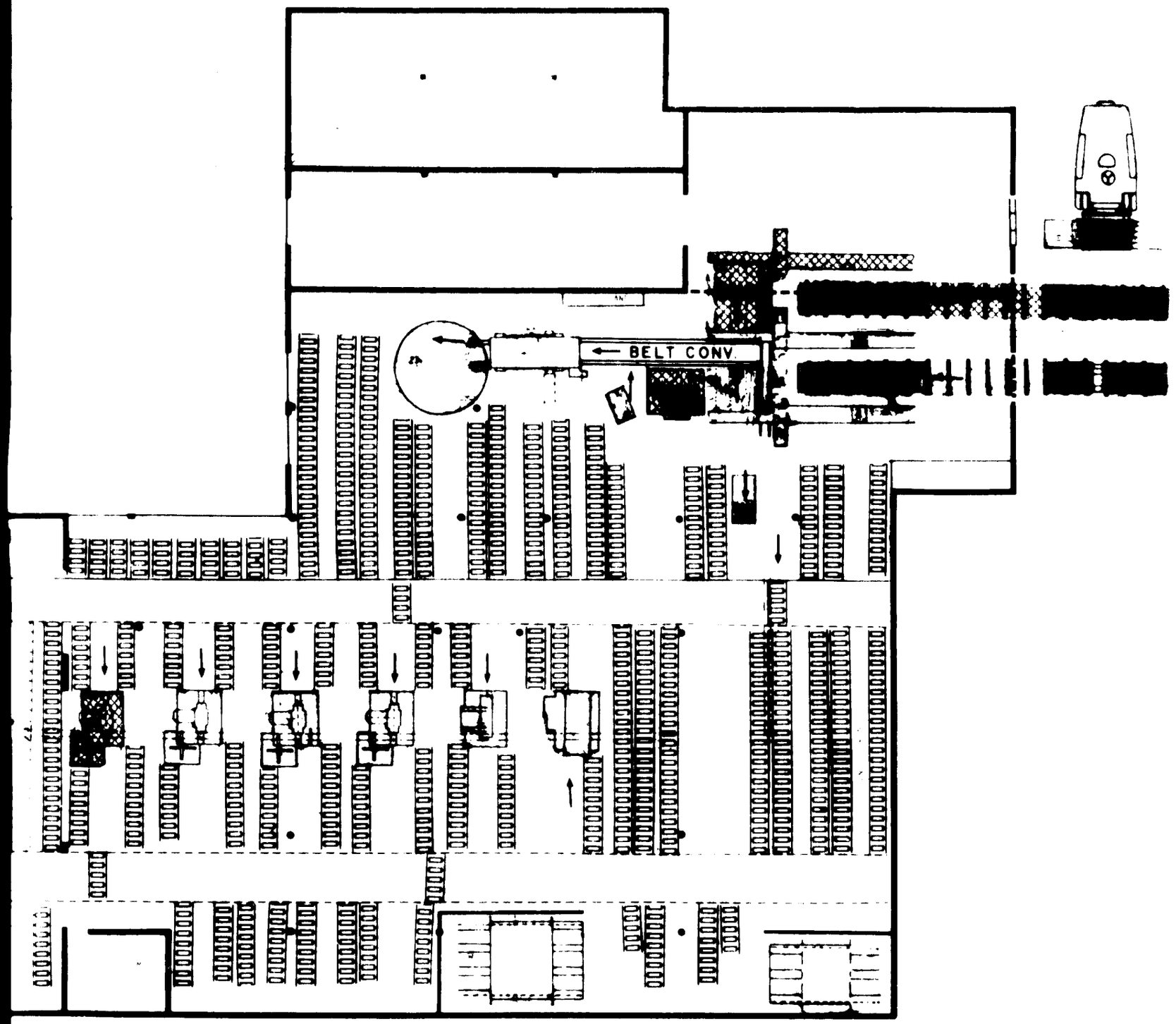

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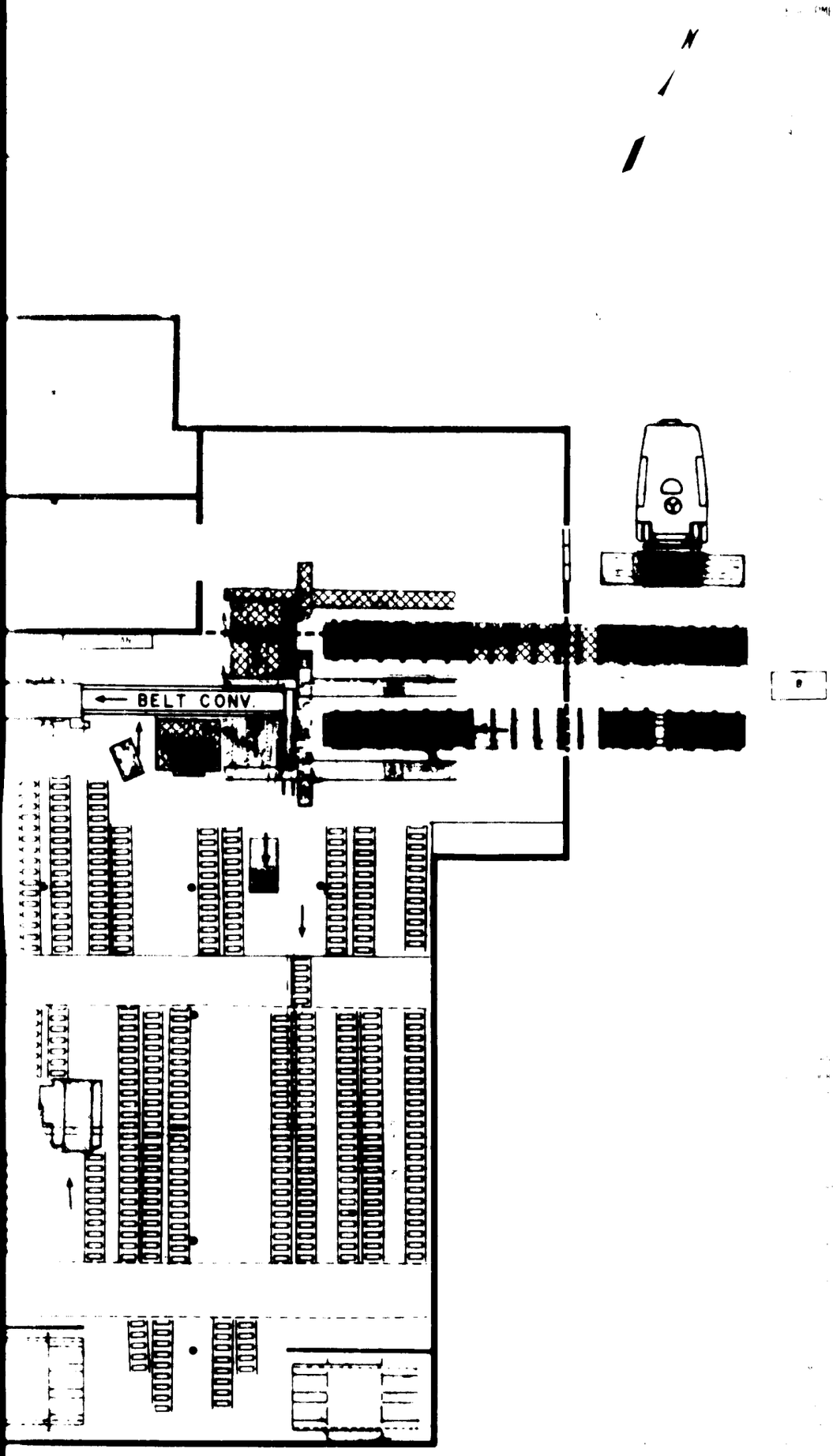

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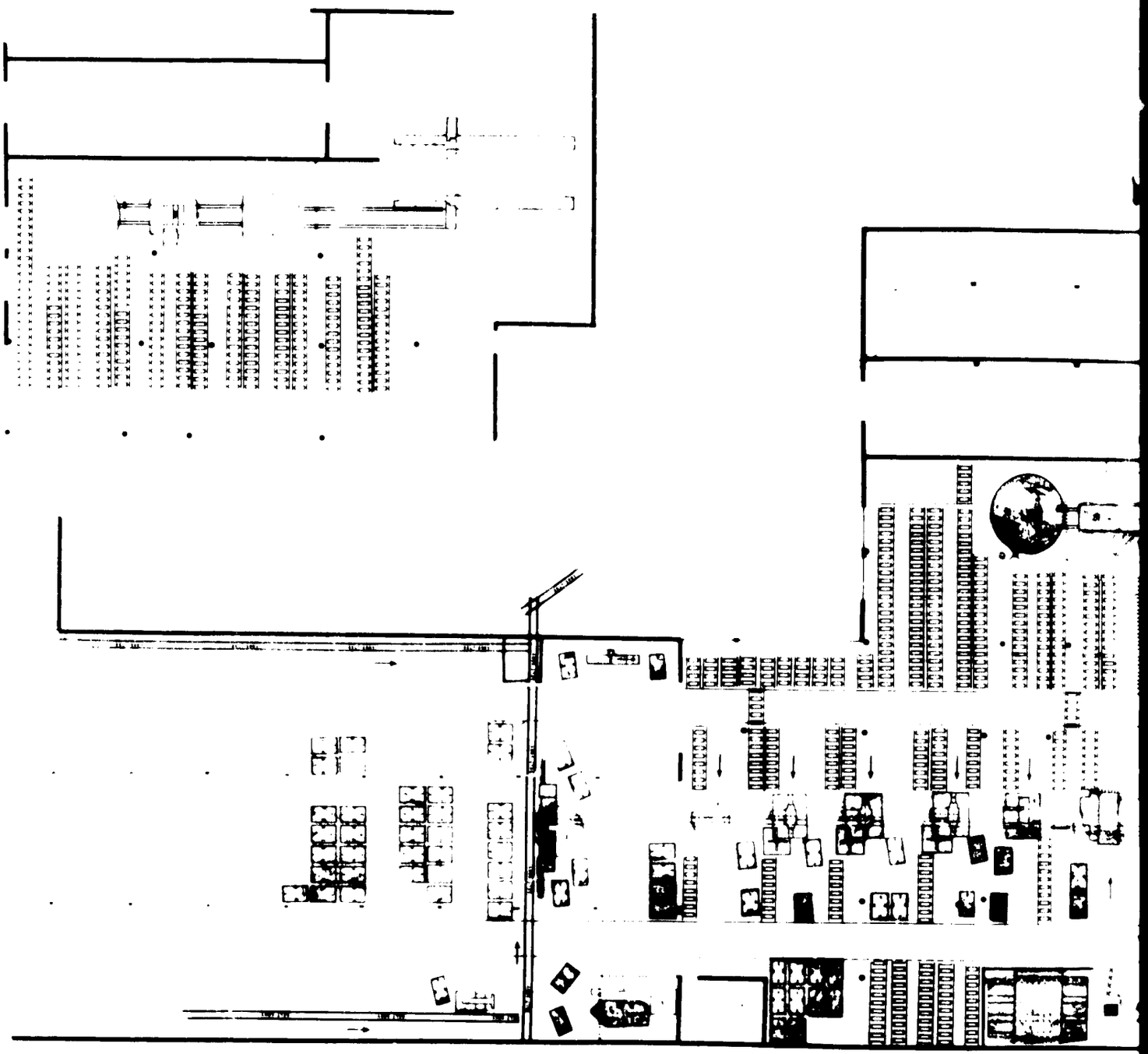

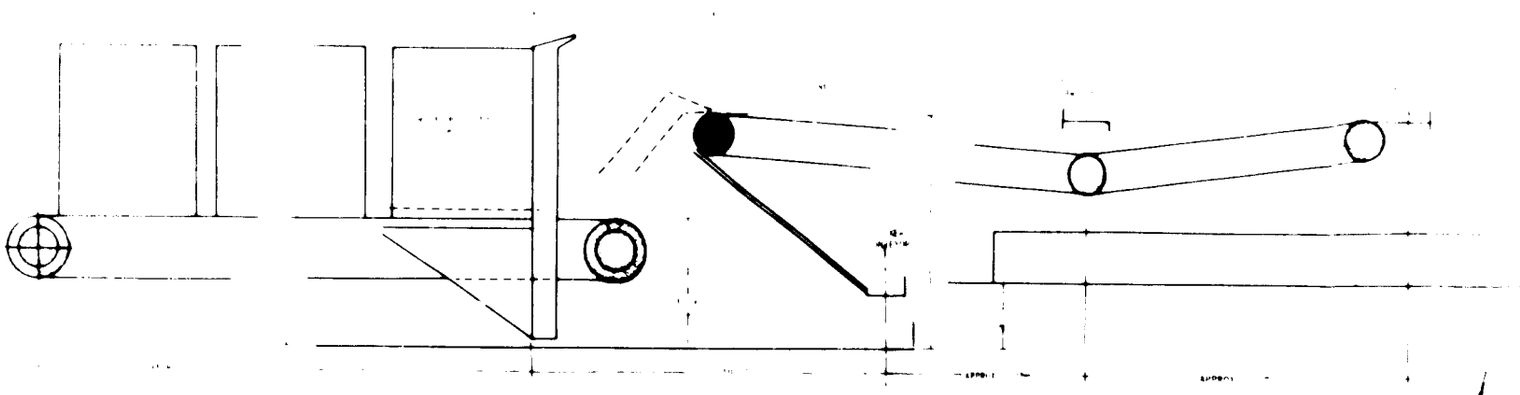

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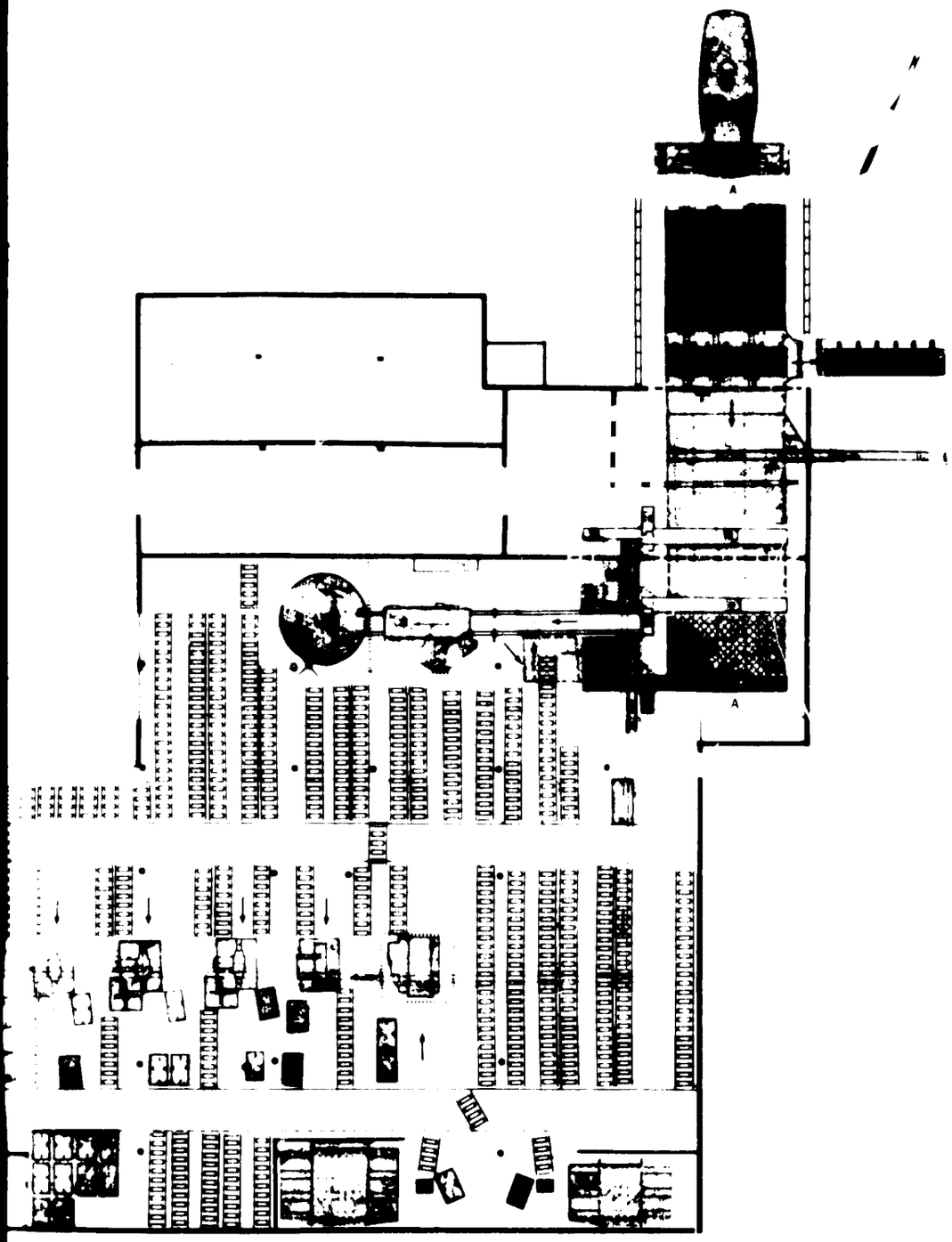

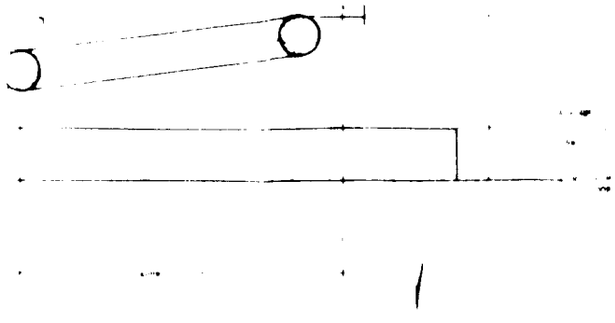

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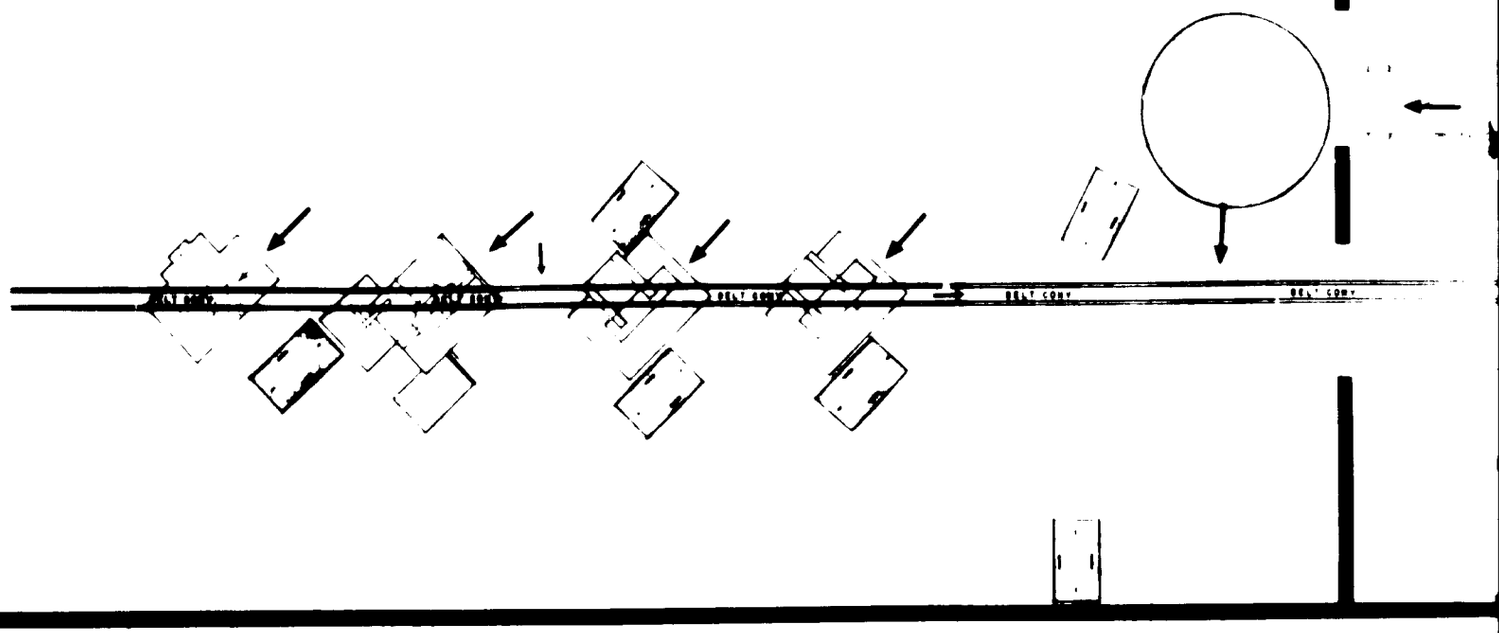

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MAIL

ROSS ASSOC

UNDP/UNIDO project for the development
industries and the creation of a centr

Annex to report by Mr. Vincent Ross on
measurement seminar for YOUR "Varda",
fitted into "Varda's" existing buildin

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DRAWN BY

DATE

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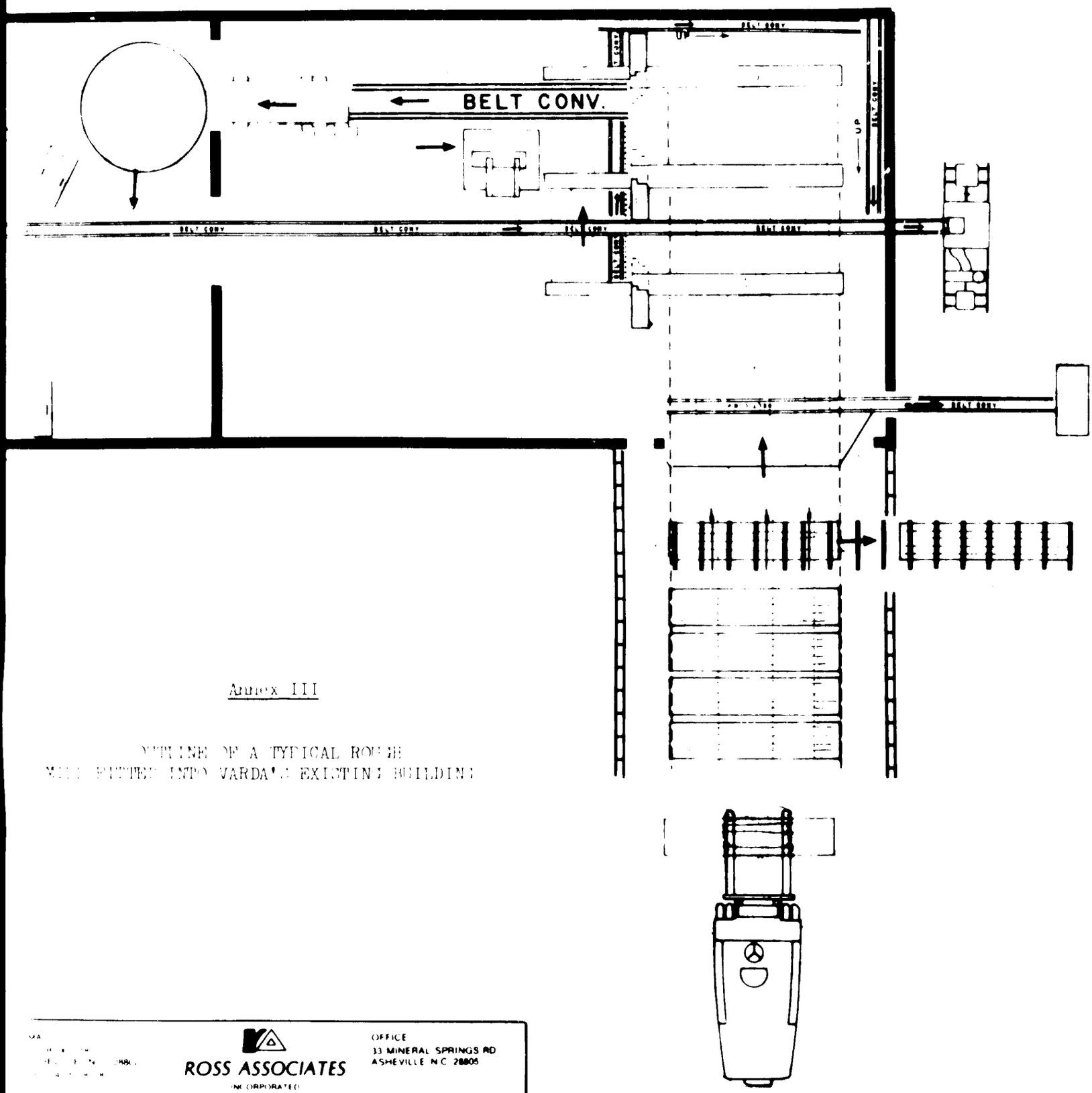

Annex III

OUTLINE OF A TYPICAL ROUGH MILL FITTED INTO VARDA'S EXISTING BUILDING

ROSS ASSOCIATES
INCORPORATED

OFFICE
33 MINERAL SPRINGS RD
ASHEVILLE N C 28805

UNDP/UNIDO project for the development of the furniture and joinery industries and the creation of a centre (DP/TUG/73/006)

Annex to report by Mr. Vincent Ross on methods improvement and work measurement seminar for OOUR "Varda", outlining a typical rough mill fitted into "Varda's" existing building.

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DATE [illegible] 1979	

SECTION 2

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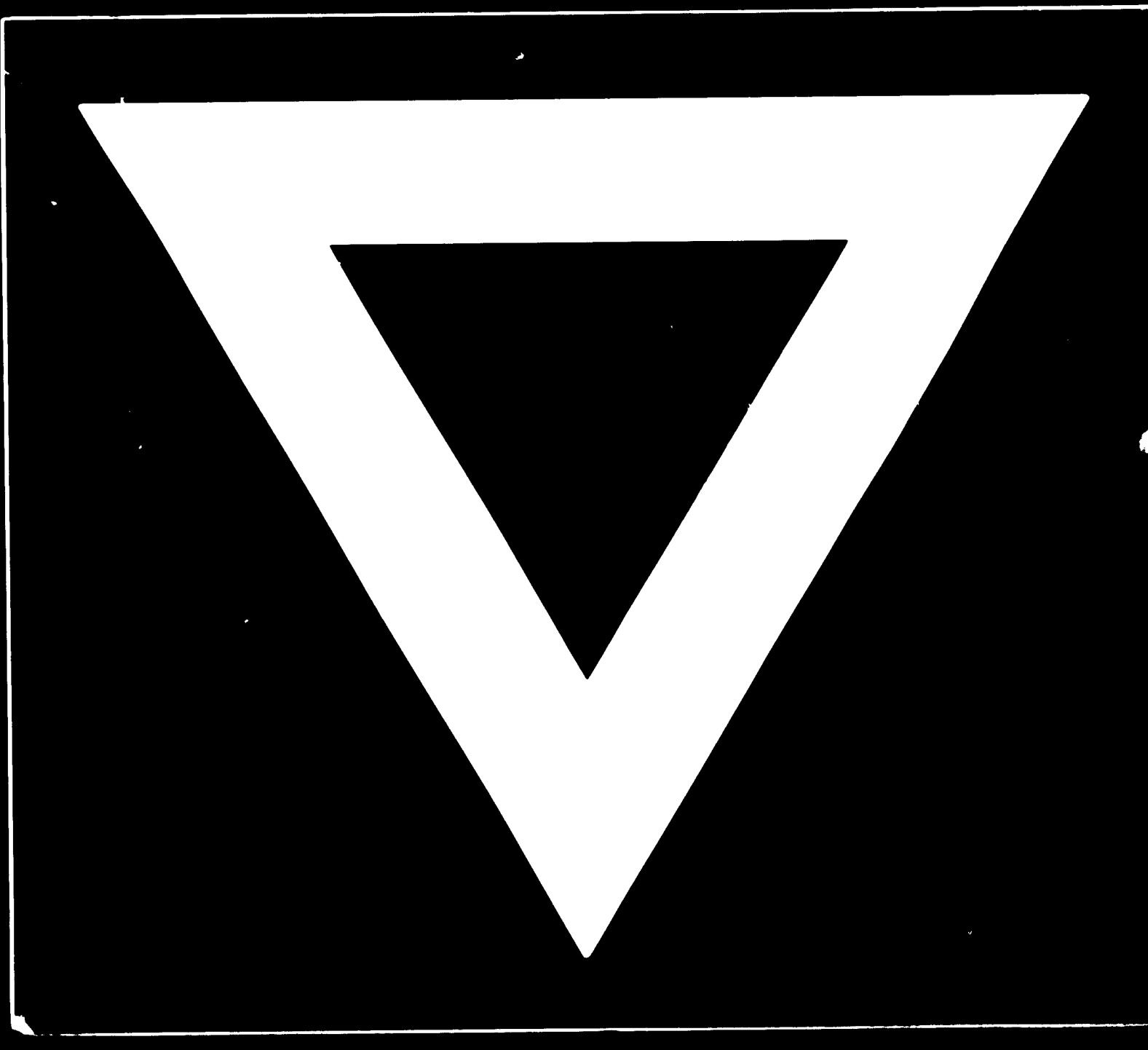

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