

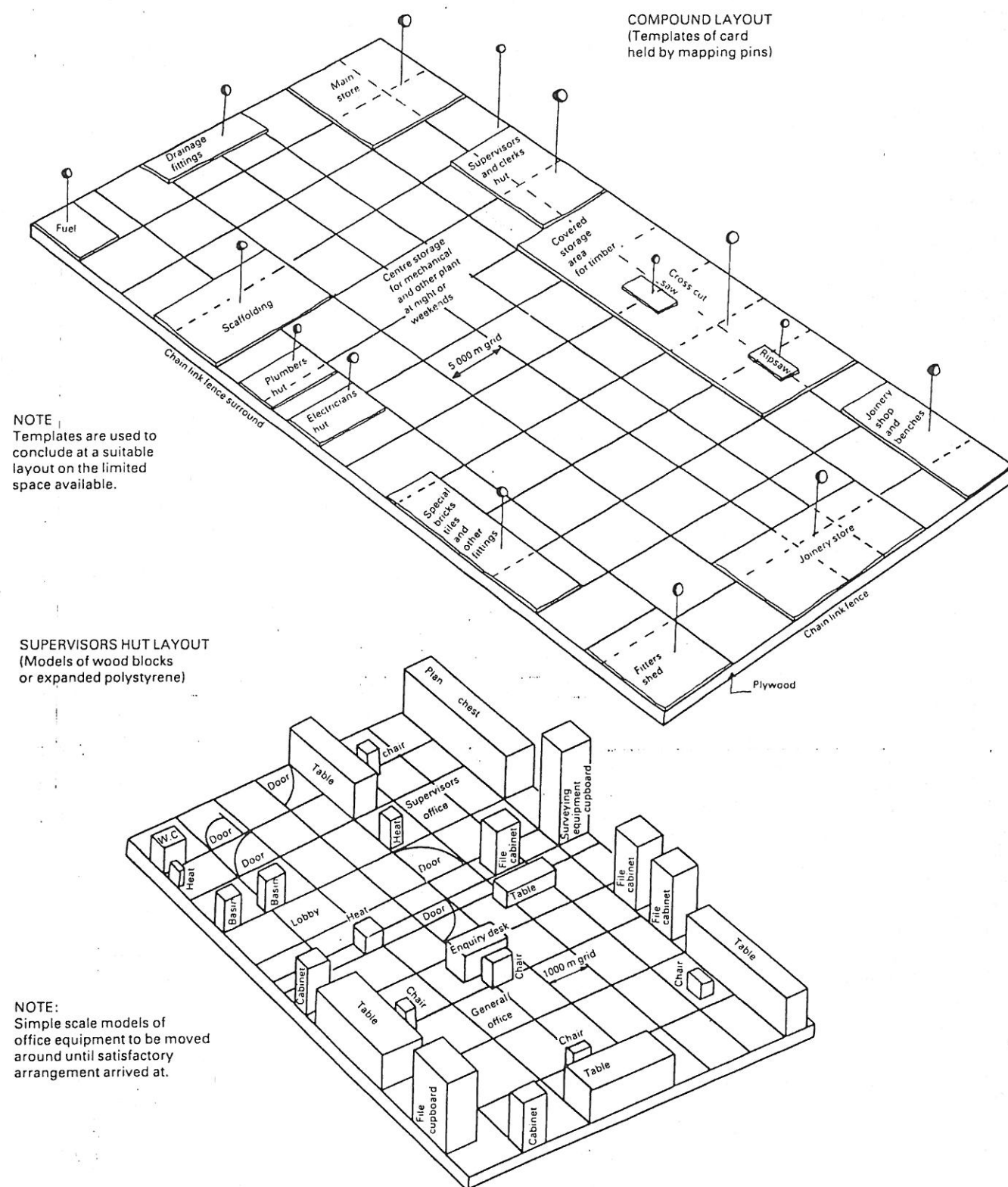


Fig. 8.1.10 Templates and models

8.2 Work measurement as a means for accurately measuring performance

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2. Activity sampling.
3. Synthesis.
4. Analytical estimating.

Each of the above plays a different role in making results of work study available to management, which can be used in the quest for information and which assists in maintaining a degree of control of an organisation. The uses to which the information can be put revolves around the setting of standards of labour/plant costs and the techniques of controlling them, i.e.

1. Standard costing and budgetary control (pre-determined costs and availability of finance).
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6. Gang balance or gang/plant balance.

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It has been a source of aggravation in the past for operatives to be secretly timed in their work situation, or be studied by management by one or more of the work measurement systems without their prior knowledge, but which eventually they discovered when work study officers were observed hiding behind brick stacks or peeping out of upper windows. Now, the operatives' cooperation is sought, through their union stewards, when a rate for an operation appears to be uneconomical or serious losses are being incurred due to inadequate gang/plant balance. When difficulties are experienced in striking the correct bonus rate for the job and the operatives are aggrieved, work study is used (time study) to arrive at an acceptable standard rate.

It is usually the case that the operatives have the final say before most forms of work study is undertaken, particularly where trade unions dominate, and therefore time studies and other work measurement studies can only be carried out after the usual consultations.

Time studies

Various equipment is used to conduct this type of study e.g.

- (a) decimal minute stop watch – fly back type – which is either calibrated for 30 minutes or 60 minutes;
- (b) clip board;
- (c) study sheets (see Figs. 8.2.2 and 8.2.3);
- (d) tape measure;
- (e) pencil and rubber;
- (f) calculator.

Job selection

Any job or operation could be studied to discover the time taken to complete it, particularly where synthetic data is being compiled for the first time; the most usual jobs, however, in an organisation which has used work study for some period of time are:

- (a) newly introduced jobs or operations;
- (b) jobs requiring the use of new techniques, new materials or new plant;
- (c) those jobs which are showing a worsening trend;
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Operatives to be studied

A study is normally taken using the services of what one would refer to as a 'qualified worker' – the type who is an average all-rounder and who has the attributes necessary for the job for which he/she is employed, i.e. degree of intelligence, skill and physical build.

The choice of operatives who are to be studied would normally be by agreement with the trade union steward, and, naturally, individuals would have to consent. Either the site supervisor or the union steward would introduce the individual to the work study officer, who should explain all the facts about how the study is conducted.

How the time study is carried out

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1. Choose the job and extent of it (when it starts and finishes).
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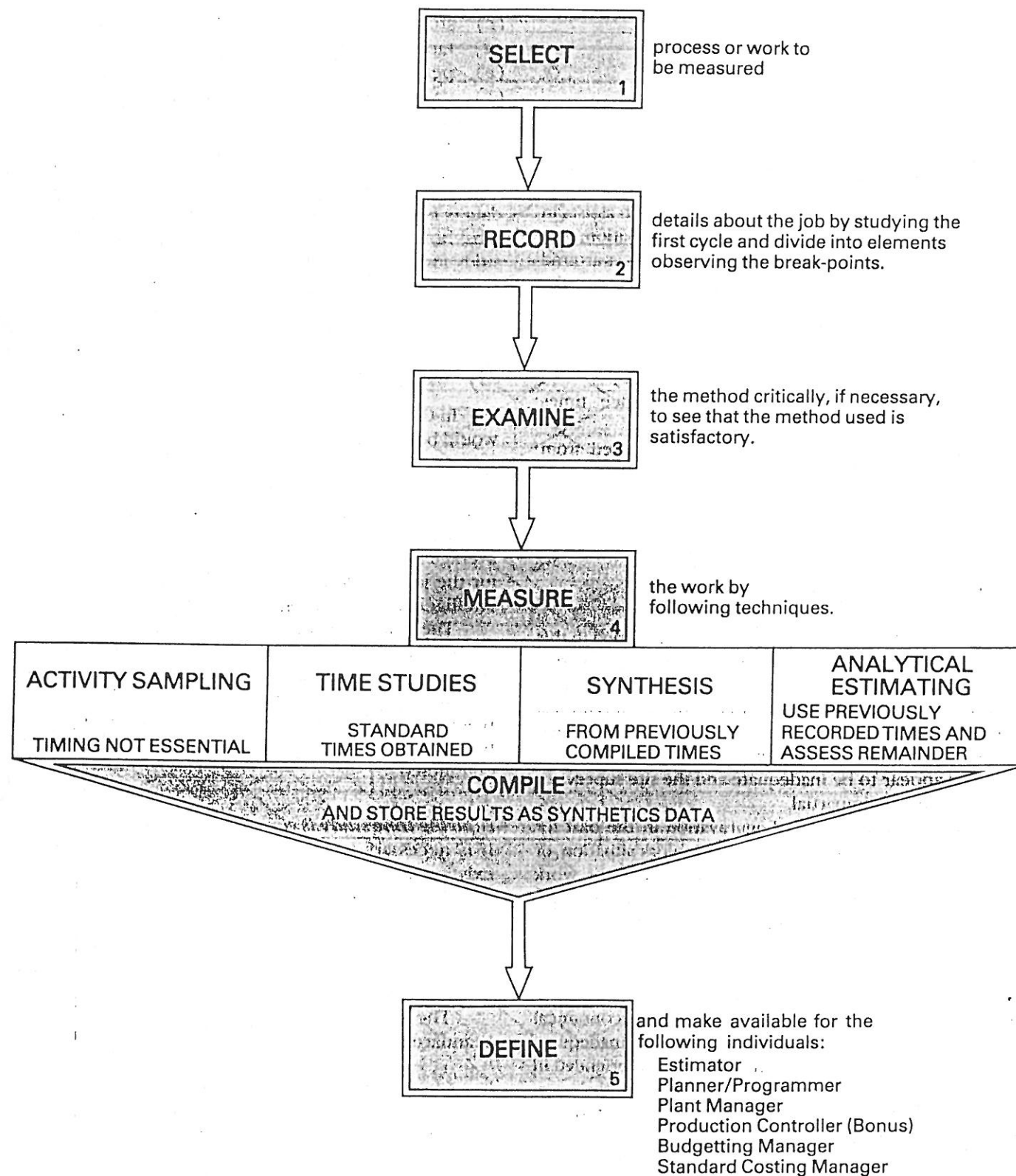


Fig. 8.2.1 Work measurement (stages in its application)

- Time each element by the 'repetitive' or 'continuous' timing method, and record in the Time Study Recording Sheet O.T. or W.R. column.
- Simultaneously to timing an element a rating should be recorded in the R column.
- Calculate the basic times using:

$$B.T. = \frac{\text{Rating} \times \text{Standard or Observed Time}}{100 \text{ Standard Rate}}$$

- Calculate the standard time using the Time Study Sheet, as shown in Fig. 8.2.3 (abstract, relaxation allowances and summary).

Rating

Because operatives work at varying degrees of speeds during a work period (depending on whether they have been, or are about to be, refreshed and revitalised with a mid-morning break, etc.) a British Standard Rating Scale is applied by the work study officer to each observed element of work produced during a study. The skill of a work study officer is greatest in applying the rating scale in assessing how fast an operative is working, and above all, how efficiently and effectively the work is being carried out.

The BS Scale ranges from 0–100 where:

- 0 represents inactivity;
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- 120 means that an operative is very skilful, fast and effective – only a small percentage of workers would be rated thus, especially over a sustained length of time.

The usual rate ranges between 70 and 130.

Abstracting

This is the collection of the basic times for each repeated element which are then added together. The element totals are then divided by how many times they have been repeated to arrive at average basic times (see Fig. 8.2.3).

Relaxation allowances

These allowances are additional percentages which are added to the average basic times to allow for delays caused by an operative having to take care of his/her basic needs, and to allow some recovery time where to complete an operation work has to be undertaken using some effort, concentration, etc., which leads to fatigue. These allowances are:

- Working position, 0–10 per cent (sitting 0%, standing 2%, stooping 5%, etc).
- Amount of physical effort, 0–20 per cent (lifting light weights, 0–10%; lifting heavy weights, 11–20%).

- Conditions of the work area, 0–20 per cent (cold, hot, bad light, dirty, fumes).
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- Monotony, 0–5 per cent (degree of repetitiveness)

Because it is expedient to do so, to these relaxation allowances are now added a standard allowance for operatives' standard needs, such as: mid-morning and mid-afternoon tea or rest breaks; attending the toilet; for washing if periodic dirty processes are undertaken.

Normally, for each element undertaken relating to building, the total percentage allowances would not exceed 40 per cent. The relaxation allowances and standard allowances are shown combined under one heading in Fig. 8.2.3, and can be remembered using SPECAM (standard, position, effort, conditions, attention and monotony).

Summary: Both the total average basic time and total relaxation allowances are added together to give total times for each element. These totals are next added to give a grand total (see Fig. 8.2.3). There now remains for only one final additional allowance to be added to the grand total time to arrive at a performance/standard time per job, which is called a contingency allowance.

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This allowance varies between 0 and 5 per cent, and is added to the grand total time for infrequent periods of delay which the work study officer expects will happen at some time, depending on the operation studied, e.g. infrequent items of work (maintenance of machines or tools); unexpected interruptions caused by other trades.

Activity sampling

Although management may have the foresight to plan ahead and use various control techniques, it may be necessary during the course of construction work to take action on site where difficulties are encountered, e.g. the level of productivity is falling and it is suspected that all is not right with the site supervision, or the gang balance of certain groups of workers is incorrect.

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The two main activity sampling systems known in construction studies are:

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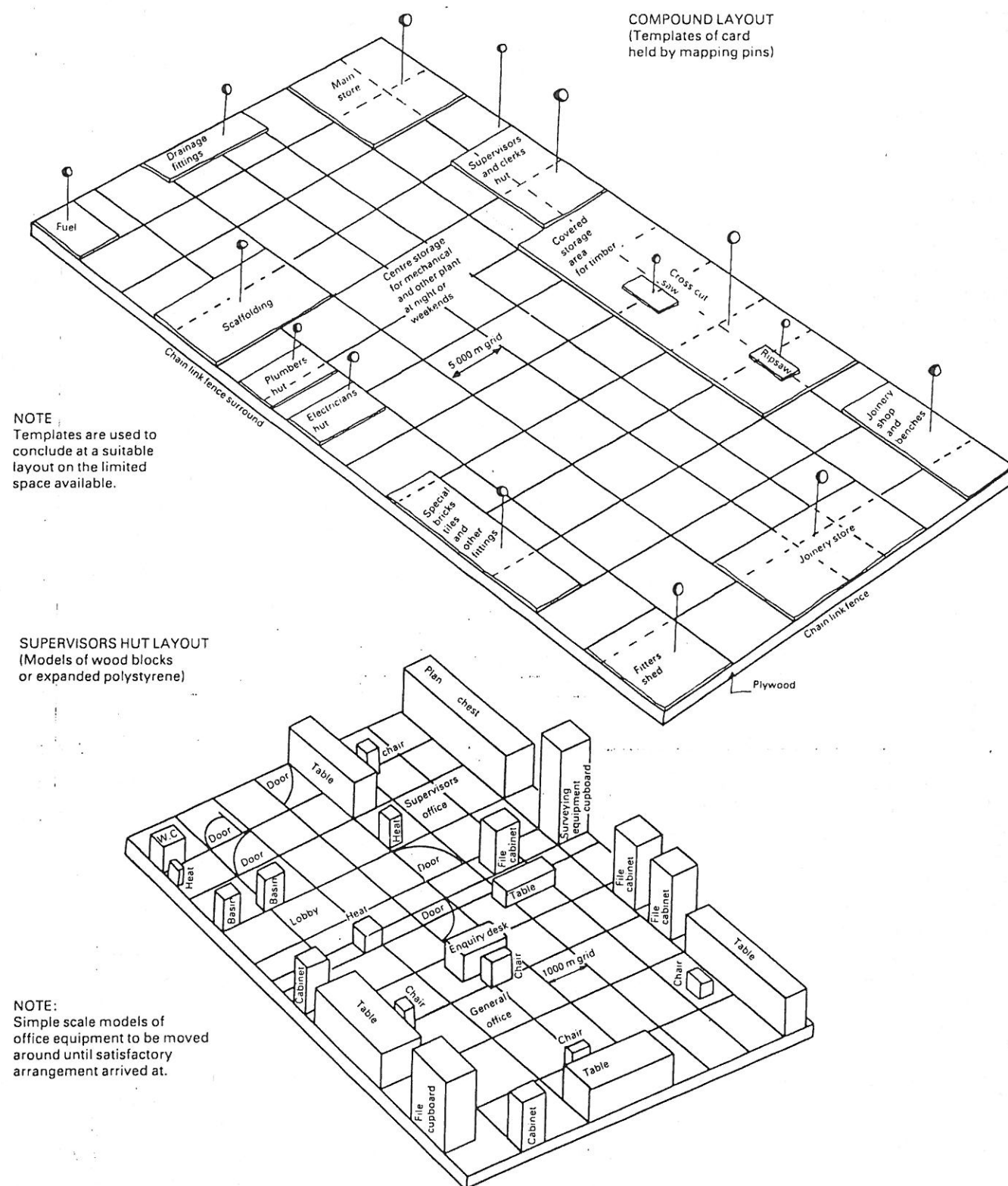


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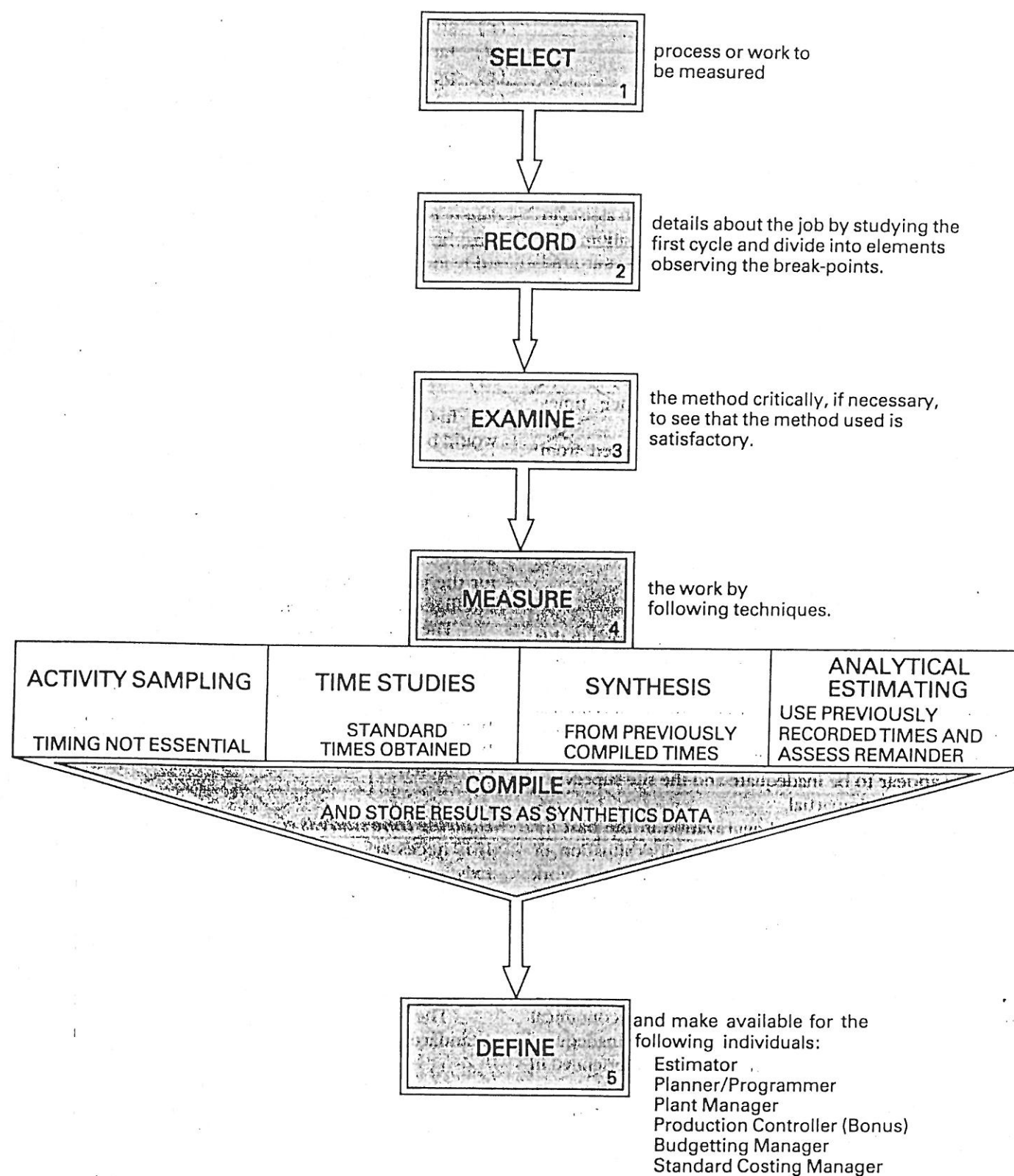


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TIME STUDY RECORDING SHEET

LOCATION: Council Housing Development, Contract No 4
 OPERATION/PROCESS: Hanging softwood panelled doors size 50mm x 2000 x 750 (no furniture).

STUDY NO: 6
 SHEET NO: 1/2

PLANT USED: —

START TIME: 9.45 am

TRADE/OPERATIVES: C + J (1 No)

FINISH TIME:

WORK STUDY OFFICER: F Joanne

DIFFERENCE

DATE: 1st January

TOTAL OBSERVED TIME:

% AGE VARIANCE:

ELEMENT	R	WR	ST	BT	ELEMENT	R	OT	BT
Note: This side of the page shows the layout for the "Continuous Timing" method.								
<u>1st CYCLE</u>								
Check time 9.45 am and start stop watch					This side of the page shows the layout suitable for the 'Repetitive Time' method - note the 3 columns only. This is the more popular system.			
1. Collect door, change work position and arrange tools.	100	3.55	3.55	3.55	1	95	3.69	3.51
2. Fit hanging edge of door.	90	9.27	5.72	5.15	2	120	4.88	5.87
3. Fit head of door.	90	13.33	4.06	3.65	3	90	4.50	4.05
4. Mark and plane door to frame width.	110	20.67	7.34	8.09	4	100	8.00	8.00
5. Mark and plane bottom of door	120	27.38	6.71	8.05	Studies the scenery	17	(3.77)	
6. Offer up the door and mark hinge positions	105	29.13	1.75	1.84	3	95	7.00	6.65
7. Cut out for one hinge and door and frame	100	5.98	6.85	6.85	6	90	1.56	1.40
9. Adjust door	90	14.22	2.22	2.00	7	100	6.70	6.70
10. Clean up shavings.	95	16.13	1.91	1.82	8	100	6.20	6.20
<u>4th CYCLE</u>								
Note: A decimal stop-watch on a long study will keep completing a full revolution (watch usual only 30 minute recording) and causes a little extra calculation procedure. See number 6 element. W.R. as hands of watch completes one revolution.								
	90	14.22	2.22	2.00	2	100	5.20	5.20
	95	16.13	1.91	1.82	3	120	4.80	5.76
					4	105	7.41	7.78
					5	100	7.02	7.02
					6	115	1.82	2.09
					7	110	6.38	7.02
					8	90	6.34	5.71
					9	95	2.34	2.22
					10	100	1.85	1.85
					1	100	3.44	3.44
					2	90	5.60	5.04
					3	80	4.28	3.42
					4	80	7.62	6.10
					5	90	7.09	6.38
					6	100	1.93	1.93
					7	105	6.60	6.93
					Has a smoke	17	(2.65)	
					8	120	5.81	6.97
					9	120	1.96	2.35
					10	115	1.74	2.00
Note: After each element reading the stop watch clicked back to zero; hence, in the O.T. column there is a direct repetitive reading								

NOTE: R = RATING; WR = WATCH READING; ST = SUBTRACTED TIME; BT = BASIC TIME; OT = OBSERVED TIME

Fig. 8.2.2

TIME STUDY CALCULATION SHEET

Study No. 17
 OPERATION/PROCESS Hanging Softwood Panelled doors Size 50mm x 2000 x 750 (no frame)

SHEET NO: 2/2
 PREPARED BY: F. Joanne.

1. ABSTRACT (FROM TIME STUDY RECORDING SHEET)

2. RELAXATION ALLOWANCES

3. SUMMARY

NO.	ELEMENT	BASIC TIMES (ON EACH REPEATED ELEMENT)						TOTAL REPEATED	AVERAGE BASIC TIME (MINS)	Standard (5-10%)	Position (0-10)	Effort (0-20)	Conditions (0-20)	Attention (0-10)	Monotony (0-5)	TOTAL % RELAXATION ALLOWANCES	AVERAGE BASIC TIME	TOTAL % RELAXATION ALLOWANCES	TOTAL: AVERAGE BASIC TIME PLUS TOTAL % RELAX ALLOWANCES
1	Collect door, change work position and arrange tools	3.55	3.51	3.60	3.44	minutes		14.10	3.53	10	2	10	5	1	1	29	3.53	29	4.55
2	Fit hanging edge of door.	5.15	5.87	5.20	5.04			21.26	5.32	10	3	12	5	2	0	32	5.32	32	7.02
3	Fit head of door.	3.65	4.05	5.76	3.42			16.88	4.22	10	3	12	5	2	0	32	4.22	32	5.57
4	Mark and plane door to frame width.	8.09	8.00	7.78	6.10			29.97	7.49	10	3	12	5	2	0	32	7.49	32	9.89
5	Mark and plane bottom of door.	8.05	6.65	7.02	6.38			28.10	7.03	10	3	12	5	2	0	32	7.03	32	9.28
6	Offer up the door and mark hinge position	1.84	1.40	2.09	1.93			7.26	1.82	10	2	5	5	3	0	25	1.82	25	2.28
7	Cut out for one pair of hinges (75mm)	6.85	6.70	7.02	6.93			27.50	6.88	10	1	8	5	3	0	27	6.88	27	8.74
8	Fit hinges to door, and door and frame	6.02	6.20	5.71	6.97			24.90	6.23	10	2	10	5	2	0	29	6.23	29	8.04
9	Adjust door	2.00	1.92	2.22	2.35			8.49	2.12	10	1	8	5	2	0	26	2.12	26	2.67
10	Clean up shavings	1.82	1.67	1.85	2.00			7.34	1.84	10	1	2	5	0	1	19	1.84	19	2.19
										GRAND TOTAL TIME:								60.23 mins	
										CONTINGENCY ALLOWANCES: 1%								0.60 mins	
										PERFORMANCE/STANDARD TIME: Per Door								60.83 mins	
										OUTPUT PER HOUR: (if required)									

Fig. 8.2.3

less than was estimated or experienced in past projects; also, the bonus earnings may have dropped and this could be a cause for concern as output could affect the contractor's position regarding the meeting of target dates. Of course, the work study officer could undertake this form of study but without the knowledge of either the operatives or site manager.

The study is conducted about once each hour to obtain the most accurate results. The contracts manager or work study officer simply walks around the site observing as many of the clocked-on operatives in their work situation as possible. The idea is to record, on small mechanical counters (one held in each hand), those operatives who are actively working, and those who are inactive at the moment of observation. Those not active are recorded, say, on the right-hand counter, while those who are active are recorded on the counter held in the left hand.

It is necessary to avoid making each tour of the site every hour on the hour, and using the same route. It is less conspicuous to make a tour at some period in each hour and by taking a different route each time.

Results are recorded at the conclusion of each tour on record sheets, as shown in Fig. 8.2.4, and it is essential that the numbers of operatives present on the site are obtained from the time-keeping records. This enables an observation percentage to be made by calculations using the total numbers of operatives observed (number of inactive operatives plus those that are active). For example:

- (a) assume number of operatives on-site to be 120;
(b) total of operatives observed is 110.

$$\text{observation percentage} = \frac{110}{120} \times 100 = 91.7\%$$

If the answer is greater than the recommended limit of 90 per cent this study is taken as valid. If the percentage is less than 90 per cent the study is discounted.

This form of study would best be conducted over a whole week period for the best results, unless it was so obvious that the operatives were spending too long on their rest breaks during the day without the site manager objecting, or not enough close supervision is being maintained at the workplace.

The study should be undertaken in the early stages of a contract so that any recommendations can be implemented to improve productivity and to maintain some acceptable control over costs. It may lead to the replacement of the site manager.

The results are plotted/drawn on a chart as suggested in Fig. 8.2.5, with the shaded part (usually in red) to show the percentage inactivity. This is a clearer method of illustrating how efficiently the site is being run.

Random Observation Study

This method of observation is used for checking the activity of a gang of workers, but its application is limited to gangs of up to six individuals because of the difficulty in studying a greater number simultaneously.

The recordings of this form of study are used to analyse the operations undertaken by each gang member. The percentage of each operation can also be compared with the other operations in the process, but particularly against the estimated figure.

An observation of each gang member is taken, say, every 10 minutes or more, and a chart or record sheet (see Fig. 8.2.6) has recorded on it: the gang members code (A–D), the operation being done at the moment of observation and the number of the observation.

Synthesis

This is a work measurement technique which is used to obtain a duration or time for doing a job. The data for working out the duration is obtained from records which are retained by the work study department of previous time studies; this data is known as synthetic data.

One or both of the following two durations or times can be recorded and are referred to as synthetic data:

1. Standard times – the time it takes to hang a door; fit a lock; lay 1000 bricks (with allowances being added for relaxation times, standard allowances and contingency allowances).
2. Element times – the time taken to do an element of work, such as: mark a hole on steel; drill a hole in 6 mm thick steel; attach a bolt to steel, etc.

In the first example of recording standard times, e.g. hanging a door, generally speaking for each door that will be hung in the future of the same type, thickness and size there are few conditions which could change and have an affect on the time for hanging a door. Perhaps temperature affects a worker's speed, but not normally while working inside a building. Therefore, it is prudent to record the standard time for hanging doors of different types, thickness and size so that these records or data can be used in similar job situations.

Where a one-off, different sized door is to be fixed a standard time can be calculated using the synthetic data which is now available but perhaps is recorded using the element times. One divides the work associated with hanging a door into elements as in time studies, and similar/identical element times are extracted from the synthetic data perhaps with an adjustment for minor variations, as shown in the example in Fig. 8.2.7. This mode of calculation for standard times is known as 'synthesis', and reduces the need to carry out time studies for every job or process as past records for similar type elements are used.

In the worked example (Fig. 8.2.7) the data extract from synthetic data is for the hanging of a 50 × 2000 × 750 mm softwood panelled door (shown in Figs. 8.2.2 and 8.2.3), but the new door under study is only 50 × 1500 × 250 mm. Therefore, as an example, in element 2 (fitting hanging edge) while the thickness is the same in both cases, the length to be planed is one quarter less than that for a 50 × 2000 × 750 and an adjustment is allowed, as shown, of minus 1.33 minutes from the original element's

FIELD ACTIVITY COUNT RECORD SHEET

CONTRACT Hospital Extension No 25

OBSERVER D. Helan

DAY Monday

DATE 1st January 19.....

STUDY NO: 36
SHEET NO: 1

TIME OF STUDY	ACTIVE		INACTIVE		NUMBER OBSERVED	TOTAL NO PRESENT ON-SITE	OBSERVED % (MIN. 90%)	NOTES
	No	%	No	%				
8.15 – 8.28	49	70	21	30	70	75	93	Temp 16°C
9.05 – 9.15	54	71	22	29	76	78	97	Sunny 18°C
10.15 – 10.22	62	86	10	14	72	78	92	" 20°C
10.50 – 10.59	53	71	22	29	75	78	96	" 20°C
11.30 – 11.38	59	79	16	21	75	78	96	" 21°C
13.08 – 13.20	39	52	38	48	77	78	99	Long Lunch 21°C
14.00 – 14.09	68	92	6	8	74	78	95	Sunny 21°C
15.17 – 15.25	50	68	23	32	73	78	94	" 21°C

NOTE: the minimum % observed to be not less than 90% otherwise study is void.

← PLOTTED RESULTS FOR MONDAYS STUDY

Fig. 8.2.4

FIEL. ACTIVITY COUNT CHART – RESULTS TO SHOW LEVEL OF ACTIVITY

CONTRACT: Hospital Extension No 25
OBSERVER: D. Helan
PERIOD: 1st Jan 19..... - 21st Jan 19.....

DAY	WEEK NO 1												WEEK NO 2				
	Study hour number												Study hour number				
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9
MONDAY																	
TUESDAY																	
WEDNESDAY																	
THURSDAY																	
FRIDAY																	

NOTE: In study 6 of the first week there is excessive inactivity because supervisor does not clear the canteen promptly each day after lunch.
The shaded portion of each hourly square (usually in red) indicates the amount of inactivity during each observation as a simply illustration to management.

Fig. 8.2.5

RANDOM OBSERVATION STUDY

CONTRACT: Phase 1 Road Contract No 32
GANG/PLANT: Drain layers (flexible jointed clay pipes)
OBSERVER: F. Joanne.

Study No: 10
Sheet No: 1
Date: 1st January 19.....

Operative/ plant		Observation number														
		1	2	3	4	5	6	7	8	9	10	11	12	13		
A	Lab	BPS	BPS	BPS	IT	BPS	BPS	IT	BPS	IT	BPS	BPS	IT	BPS		
B	Lab	BP	IT	BP	IT	BP	IT	BP	BP	IT	IT	BP	BP	IT		
C	Drain/L	IT	SPS	SPS	SPS	PP	IT	SPS	SPS	SPS	LP	LP	LP	SPS		
D	Drain/L	IT	LP	LP	LP	LP	LP	IT	LP	LP	IT	SPS	SPS	LP		

KEY IT = IDLE TIME, BPS = Barrow Pea Shingle, SPS = Spread Pea Shingle, BP = Barrow Pipes, LP = Lay Pipes, PP = Pass Pipes

Note: As can be seen, this method of work measurement highlights the idle time, and due to it the gang size can be adjusted – result: a gang of 3 may be more suitable instead of 4.

Fig. 8.2.6

SYNTHESIS FROM ELEMENT DATA

PROCESS: Hanging SW Panelled Door Size 50x1500x250mm
 PREPARED BY: B. Shirley

STUDY NO: 72
 SHEET NO: 1
 DATE: 1st Jan 19.....

ELEMENT	BASICTIME FROM SYNTH- ETICS DATA	ADD/ SUBTRACT FOR VARIATION	TOTAL BASIC TIME	RELAXATION ALLOWANCES						TOTAL RELAX. ALLOW.	TOTAL BASIC TIME + RELAXATION ALLOWANCES.
				S	P	E	C	A	M		
1. Collect door and change work position and arrange tools	3.53	no variation	3.53								
2. Fit hanging edge of door	5.32	-1.33	3.99								
3. Fit head of door	4.22	-1.41	2.81								
4. Mark and plane door to frame width	7.49	-1.87	5.62								
5. Mark and plane bottom of door	7.03	-2.34	4.69								
6. Offer up door and mark hinge positions	1.83	no variation	1.83								
7. Cut out for one pair of hinges (75mm)	6.88	"	6.88								
8. Fit hinges to door and door to frame	6.23	"	6.23								
9. Adjust door	2.12	"	2.12								
10. Clean up shavings	1.84	"	1.84								
GRAND TOTAL											
CONTINGENCY ALLOWANCES: (0-5%)											
PERFORMANCE/STANDARD TIME: per door											
OUTPUT PER HOUR: (if required)											

NOTE: The basic time column shows element basic times obtained from SYNTHETICS DATA (stored information of identical work elements from previous time studies) which may need adjusting because of various sizes of new work. Note that the element no. 2 basic time is 5.32 for 'fit hanging edge of door', but this door, although identical in construction and thickness, has an edge which is bigger than the door now being studied by about 1/4; therefore, 1/4 (1.33 mins) has been deducted to give the Total Basic Time.

Relaxation, standard and contingency allowances are next assessed, as previously explained in Time Studies.

Fig. 8.2.7

basic time of 5.32 minutes, making a basic time for the smaller door of 3.99 minutes.

Analytical estimating

This is yet another work measurement technique but which is used in calculating standard times for non-repetitive processes or jobs. It may be too expensive and time consuming to carry out time studies for a one-off job. Also, there may not be sufficient recorded previous elements or standard times in a firm's synthetic data, making the technique of synthesis inoperable.

Analytical estimating should be undertaken by someone with considerable experience in work study, or a person (site supervisor) who may have had vast practical experience and with a knowledge of how long trade operations take.

The technique, where a one-off job's basic times are to be prepared, is to break the job down into elements, as in all time studies. Each element's basic time is assessed at a standard rate, and where it is possible synthetic data is used; this is a less precise method of obtaining standard times because it relies on judgement, but it is assessed as being satisfactory in such situations as described.

The example in Fig. 8.2.8 deals with the removal of an existing overflow and warning pipe which is too small in diameter, and which is replaced with a bigger plastic one. Some of the basic times are obtained from synthetic data, and others by analytical estimating (assessment from experience).

In using this technique a rate for undertaking the work can be fixed so that the operative, if there is a bonus scheme in operation, can assess his/her bonus earnings.

8.3 Incentive schemes

There are two areas within which financial incentive schemes fall; those of operatives and those of managers. Each area is dealt with differently by companies either as a method of reward, or inducement to higher productivity.

Schemes for managers

1. Extra payments or increases in salaries for supervisors, managers and executives for any increased output. These usually take the form of: payments by the allocation of extra shares; a percentage of any profits earned by the company; or free holidays as a bonus for well-managed, profitable schemes.
2. Fringe benefits covering such items as: a car; sickness benefits; free education for a manager's children, especially if the manager has to frequently spend time away from home and his wife, periodically, is required accompany him.

Schemes for operatives

1. Geared incentive bonus schemes which are based on measured levels of productivity at site or shop floor level.

2. Standing bonus schemes where the cost of a bonus department set-up is either too expensive and the bonus is used as a bribe to ensure adequate numbers of employees attend work promptly and regularly during a work week.

Financial incentives for executives/managers

While some of the aforementioned are strictly financial incentive schemes used to coax the workers, staff and managers to higher productivity, others are in recognition for past efforts, or to retain the services of key personnel vital to a firm's continued success in the relevant industrial or commercial field.

It appears to be increasingly necessary for companies to add to the fringe benefits of managers/executives as a way round governments' prices and incomes policies, and which is used as a basis for appeasing vital executives, etc., who hold the keys to a company's success against competitors from home and abroad. In this regard 'alternative benefits' or 'perks' are the rewards for faithful service, and in many instances are tax free, which assists in protecting incomes against inflation.

These alternative benefits (perks) revolve around such examples as:

- (a) free lunches;
- (b) firm's issue of suits, with a nominal hire charge of a few pounds per year;
- (c) free contributions to a private medical scheme such as BUPA;
- (d) free travel abroad for wife and family while accompanying husband/father on business, or more especially to conventions;
- (e) free advice on personal affairs;
- (f) professional fees paid for;
- (g) access to newspapers and periodicals;
- (h) non-contributory pension schemes;
- (i) non-contributory insurance schemes;
- (j) free bridging loans, new fitted carpets, solicitor's fees when moving house;
- (k) low interest loans;
- (l) low mortgage rates;
- (m) free generous supply of wine for possible entertainment of prospective customers;
- (n) service contracts - in the event of the manager losing his/her job due to the firm eventually going into liquidation; or in a redundancy situation, an agreed sum of, say, £20 000 would be made available each year for up to 20 years (firm insures against this).

The 'perks' go as far as: free hairdressing for a wife who assists in the entertainment of prospective clients; the provision of food freezers to store, so called, special food for entertaining clients; stereo and TV sets. There are numerous entertainment 'perks' many of which are bona fide, but many more that abuse the system and which are used as a means of boosting executives' salaries. In offsetting these additional costs as overheads in the ac-