Peter Almström
Technology Management and Economics

Work sampling

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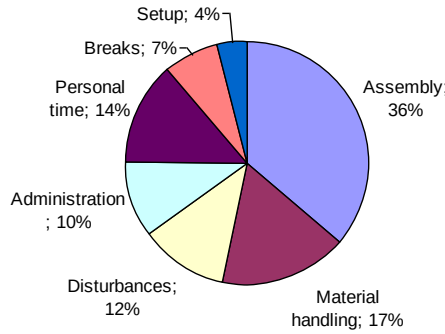
Learning objectives

- After this lecture you will be able to…
  - Do a work sampling study.
  - Calculate the needed number of observation or the statistical error in a work sampling study.
  - Know when work sampling is applicable.

Work sampling



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Alternative names

- Work sampling
- Activity sampling
- *Sv. Frekvensstudie*

History of work sampling

- L.H.C. Tippet in 1927
- British spinneries

- The proportion of observations of a specific activity is proportional to the actual time for that activity.

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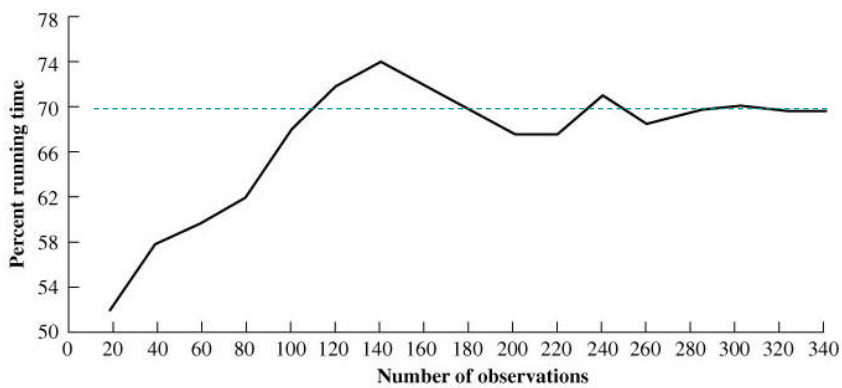
Fast to tune in on mean value



Work sampling applications

- Manual work
- Machine work
- Material (buffer) level
- Administrative work

- Overview study
- Allowances

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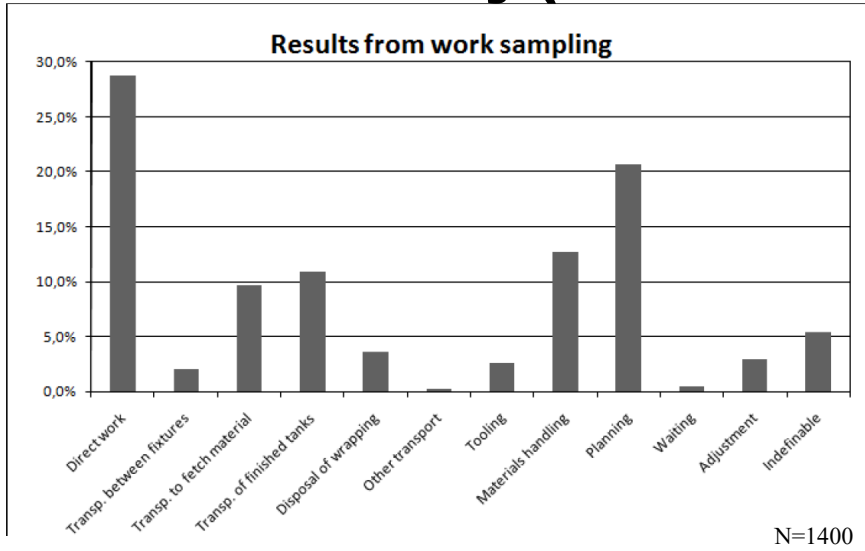
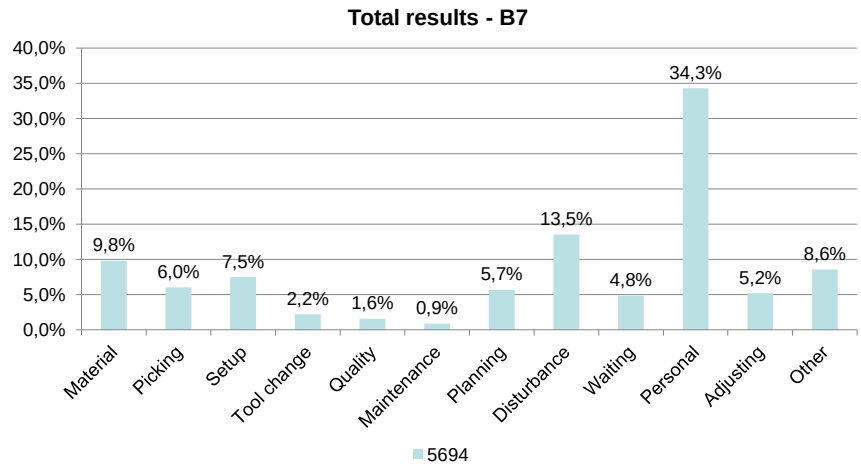
Manual assembly (in stations)



Machine operators



Bergman and Wickström, 2013

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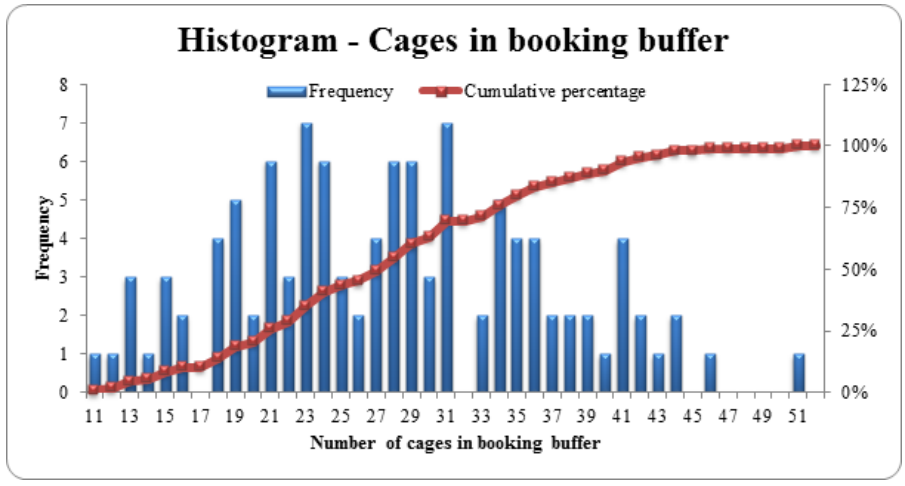
Sampling of buffer size



Belin & Hedman, 2010

How to achieve random sampling

- Random intervals
- Random objects with fixed intervals
  - Requires study of >1 object
- Use real random figures.

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Advantages of Work Sampling in comparison with Time study

- More cost efficient (5-50% of time study)
- Qualified analyst not required
- Study can be interrupted
- Less effect on the operators
- More easily accepted by the operators

Disadvantages of Work Sampling in comparison with Time study

- Time study permits a finer breakdown of activities
- No method study
- Averages of groups, no individual differences
- Risk of doing too few samples

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How to make a study

1. Determine purpose
2. What objects?
3. What activities?
4. Pre-study
5. Number of samples
6. Carry out study and analyse

Work sampling theory

$$N = \frac{z^2 p(1-p)}{e^2}$$

N=Number of observations
p=Probability of a single occurrence
e=Acceptable limit of error = σ

With 95% confidence interval z=1,96

$$N = \frac{1{,}96^2 p(1-p)}{e^2}$$

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Absolute and relative error

- e is dependent on p
- What you can say after a work sampling study is that:

  "Activity X represent YY% of total time ±e% with 95% confidence"

- Example:

  "Assembly represent 54% of total time ±4% with 95% confidence"

  $\frac{4}{54}$ = 7% relative error

  "Cleaning represent 4% of total time ±4% with 95% confidence"

  $\frac{4}{4}$ = 100% relative error

Examples

Number of observations needed when 10% relative error is acceptable

$$Smallest\_activity = 20\% \Rightarrow N = \frac{1{,}96^2 0{,}20(1-0{,}20)}{0{,}02^2} = 1537$$

$$N = \frac{1{,}96^2 0{,}10(1-0{,}10)}{0{,}01^2} = 3457$$

$$N = \frac{1{,}96^2 0{,}05(1-0{,}05)}{0{,}005^2} = 7299$$

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Example

Number of observations needed when 10% relative error is acceptable

$$N = \frac{1{,}96^2 0{,}01(1-0{,}01)}{0{,}001^2} = 38031$$

Example

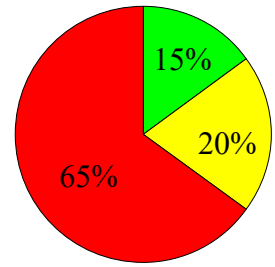
Number of observations needed when 5% relative error is acceptable

$$N = \frac{1{,}96^2 0{,}05(1-0{,}05)}{0{,}0025^2} = 29196$$

30000 observations, two samples/minute = 6 weeks fulltime

PPA

- 480 observations
- Random object



$$e = \sqrt{\frac{1{,}96^2\, p(1-p)}{N}} = \sqrt{\frac{1{,}96^2 0{,}33(1-0{,}33)}{480}} = 4{,}2\%$$

4,2% absolute error => 4,2/33 = 12,7% relative error

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Work sampling acceptance

- Possible to be impersonal
- Fast and non obtrusive
- Pedagogical challenge

Self-observation

- Especially for indirect (mobile) work
- Advantage: no extra people needed
- Disadvantage: a disturbance, less accurate
- Technology needed

Work sampling software

- For PCs, PDAs or Surfpads
- Less clerical work
- Fast results – lower cost
- Higher accuracy – fewer opportunities for errors
- Use video camera, do sampling on the movie.

- Negative: Depend on technology

Work sampling exercise

1. Value adding
   - Writing on the black board
2. Supporting
   - Changeover (change chalk)
   - Planning activity (sit by computer)
3. Not value adding
   - Disturbance (drop chalk)
   - Paid break (walk out)

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