# A Senior Project in Construction Management Technology Based on Work sampling

### Amitabha Bandyopadhyay, Roslyn Smith

### SUNY Farmingdale, NY

#### Abstract

One of the problems we face in 4-year engineering technology programs is to motivate students to work on a senior project that is based on the research methodology. Most students choose instead traditional design projects. The design projects are good for integrating knowledge from various courses, but students do not get a chance to work on new innovative areas where they have to learn new ideas and new methodologies. The project described in this paper, although not a new technique, gave the student a chance to work in a research related field. As part of the preparation for the work the student was given basic information required for any research project. A review of various related statistical concepts was also completed. This paper reflects the work done in this senior project course by the student and the advisor. The paper describes two work sampling studies, one each on a residential project and a commercial project.

### Introduction

Low productivity is a key factor in the high construction cost<sup>1</sup>. A number of problems affecting productivity can invariably be noted when the activities in progress on a typical construction site are closely observed. Although some will attribute the idleness of a construction worker to his inherent dislike of work, union rules, or some social or psychological condition, the real causes for idleness or poor productivity usually have much deeper roots. Some of the more common root causes that adversely affect productivity and costs are found in the management or supervisory areas of material handling, tool availability, site congestion, lack of information, etc.

Work sampling is an activity measurement technique that has received increased emphasis in recent years as managers struggle to control construction costs. Its simplicity and low cost make it a powerful methods improvement technique. Work sampling measures the percentage of time that the manual labor force spends in certain predetermined categories of activity. Hopefully, by knowing how the craftsmen's time is used, problem areas showing productivity will emerge. The underlying theory of work sampling is that the percentage of observations recording a man or machine as idle, working or in any other condition reflects the percentage of time actually spent in that state or condition. If the observations are randomly distributed over a sufficiently long period of time, this theory is held to be true. Work sampling as the name implies, utilizes the well established principle of drawing inferences from a random sample of a whole<sup>2</sup>. In this case the "Whole" is the total activity of the area, persons, or machines observed during the entire period of time over which observations are made. Work sampling is a practical compromise between the extremes of purely subjective opinion and the "certainty" of continuous observations.

# Historical Perspective

Work sampling technique has been around since 1935. It is generally conceded that L.H.C. Tippett, a British statistician, is the father of work sampling at that time it was used as a method of determining machine down time and its causes. Later this method was broadened to measure inactive time of men and machines to determine the causes and improve them<sup>3</sup>. It was not until 1940 that the technique was introduced to American industry by Robert L. Morrow. The technique enjoyed moderate success during the war years but failed to gain widespread use, perhaps because of a need to understand statistics and probability in order to interpret the results.

### The Study

The following steps were carried out by the student for both the residential project and the commercial project:

- 1. The problem was defined in details
- 2. The recording forms were designed
- 3. Preliminary observations were made to determine an appropriate value for p
- 4. Confidence levels were estimated
- 5. The degree of errors were estimated
- 6. Calculated the sample sizes were calculated based on the following equation:

# $n = (Z/e)^2 * p(1-p)$

Where n = sample size

Z = Z-value for the desired confidence level

e = Degree of error from the true mean

- p = proportion of time spent on activity during prl. Observations
- n for the residential project = 366 observations Observation every 20 mins for 18 days
- n for the commercial project = 378 observations Observations every 20 mins for 19 days

7. The random starting time was determined by using the random numbers

The Residential Project

The project was a construction of a one family hi-ranch house. The activities studied were sidings, widows, drywall installation, and concrete for the slab, steps and garage. The project was right off a side road, mid block in Suffolk County. The materials were all stored in one location at the north east corner of the plot. The tools used by the crew were mainly kept in a van that most of the time parked on the south side of the project.

# The Commercial Project

The project involved the construction of a supermarket. The activities studied were exterior masonry, steel reinforcing, and pouring concrete slab. The project was in a corner plot in Suffolk County. The materials were stored in mainly two locations, north east corner and south east corner. The site trailer was located on the south west corner.

# The Results

The followings are the results obtained from the residential project:

The following results are obtained from the commercial project:

- 1. Direct work -----46%
  - Handling of tool/materials -----21%
  - Placing Materials-----25%

- 2. Essential Contributory Work ------30%
  - Obtain/transport tools/materials ----- 7%
  - Receive/give instructions ------3%
  - Directing machinery or guiding Matl ------8%
  - Minor work –i.e. measuring mixing ------13%
- 3. Ineffective Work ------24%
  - Waiting for tools, materials, instruction ---6%
    - Personal breaks ------13%
    - Getting tools/materials from stock pile -----5%

Comments on Results

The results from the two projects were similar. The direct work components were 41% and 46%, that means less than 50% of the time workers were engaged in some things that produces revenue. But, this follows the national trends found in other studies. The essential contributory works in the projects were 30% and 35% shows that the support works generally take third of the time of the project. To minimize the support work, careful site planning is needed. Highly trained workers also help to reduce time in this category. The ineffective times on the job for the projects were 24% for both. Personal breaks on projects although seems high, were again within the national range. Having good supervision and excellent site planning may improve the situation. The placement of the stock piles and the location of the work trailer definitely affect the downtime.

### Bibliography

- 1. H. Randolph Thomas and Mason Holland, Work Sampling Programs: Comparative Analysis, Journal of the Construction Division Vol. 106 (12/1980): 519-534. ASCE
- 2. H. Randolph Thomas and Jeffrey Daily, Crew Performance Measurement via Activity Sampling, Journal of Construction Engineering and Management, Vol. 109 (9/1983); 309-320 ASCE
- 3. David F. Rogge, and Richard Tucker, Foreman Delay Surveys: Work sampling and Output, Journal of the Construction Division, Vol. 108 (12/1982): 592-604