

# TIME AND MOTION STUDY OF THE CIRCULATION SYSTEM IN THE NATIONAL TECHNICAL TEACHERS' COLLEGE (NTTC) LIBRARY, YABA - LAGOS, NIGERIA

## Abstract

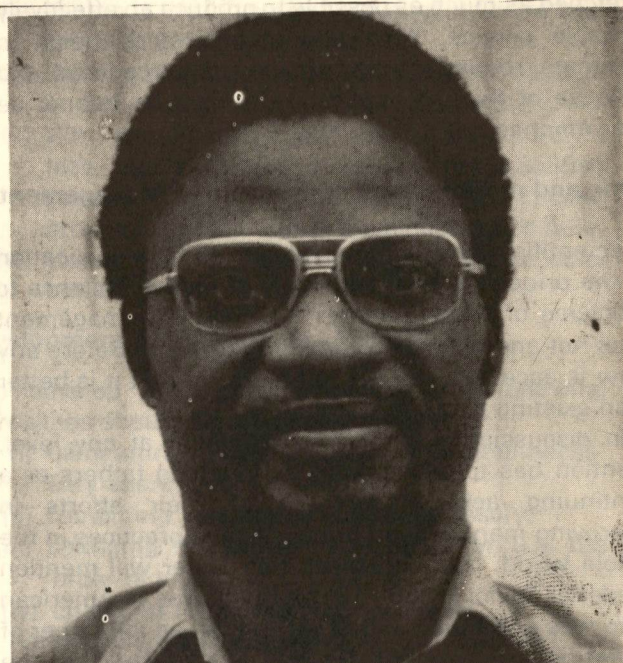
Time and motion study is defined and seen as a major aspect of a scientific management study. Its application and relevance to library operations are discussed. What to do when making a management study is further discussed and it is finally agreed that time and motion study is made to improve upon previous practices and procedure; thereby bringing about routine or operational efficiency in libraries.

## Short History of the NTTC

The National Technical Teachers' College (NTTC), is a technical College of Education training teachers for the award of the Nigerian Certificate of Education (NCE) Technical and the one year Technical Teachers' Certificate (TTC) for candidates who are already qualified in their various technical and commercial professions. The TTC is more or less a post-graduate programme in education.

The birth of the NTTC was sequel to the recommendations of Gailer in his report titled "A National Plan for the Development of Technical Education in the Federal Republic of Nigeria". As a follow-up of this report, an International Labour Organization Special Fund Project was launched to train vocational Instructors. The special project fund was terminated in September, 1967. The Federal Government of Nigeria started on technical and commercial subjects in secondary schools, vocational training centres, technical colleges, polytechnics and Colleges of Technology. It was for this purpose that the NTTC was established by the Federal Government with the assistance of the United Nations Development Programme (UNDP). The United Nations Educational, Scientific and Cultural Organization (UNESCO) was made the executing agency on behalf of the UNDP and the Federal Ministry of Education, the co-operating agency on behalf of the Federal Government. The UNDP project terminated in 1974 with some UNESCO experts remaining until 1976 to complete the installation of laboratory equipments supplied by the UNDP.

When the College was founded in 1967, it was meant to offer a one-year teacher training course for candidates possessing recognized technical and commercial certificates with appropriate post-qualification experience and wishing to become teachers of technical and commercial subjects. There was, however a shift of emphasis from the TTC to the NCE (Technical) in Engineering and Business Studies. The NCE (Technical) and NCE (Business) were introduced in 1968 and 1970 respectively. It could be seen from all these that the NTTC Library clientele are post-secondary school students and graduate teachers in various subjects taught in the College. These subjects include Electricity/Electronics, Mechanical and Civil Engineering, Accountancy, Secretarial Studies, Laboratory Technology and Nursing.



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## What is Time and Motion study

Time and motion study is the "Systematic observation, analysis and measurement of the separate steps in the performance of a specific job for the purpose of establishing a standard time for each performance, improving procedures and increasing productivity"<sup>1</sup>. Time and motion study could also be called motion and time study or separately called time study or motion study. However, the two have to go together. Time study is "recording the time it takes people to perform tasks (often analysed into small elements for convenience of measurement)"<sup>2</sup>. Motion study on the other hand determines the constituent steps of a job. In the United States time study is synonymous with work measurement while motion study is synonymous with method study. Method study, for the sake of clarity is defined as "the systematic recording and critical examination of existing and proposed ways of performing tasks involving human activity in order to

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develop and apply easier and more effective methods and reduce costs"<sup>3</sup>

From the above definitions of time and motion study and its other names, it could be safely inferred that it is a management work-study intended to improve upon previous practices and procedures, eliminating unwanted efforts and reducing to the barest minimum the number of elements of a particular job for effective and functional operation. This facilitates reduction in costs and in turn brings about more profit to the organization. Although the library is not a profit making organization, there is still the need for making time and motion study applicable since this study is capable of improving services. In this era of inadequate funding, the scarce fund should be judiciously used and stretched as much as possible to produce an effectively enviable service. Time and motion study helps to eliminate redundant and unwanted procedures and because of this, its application to libraries cannot be over-emphasized.

### **Time and motion study and Scientific Management**

Scientific management is said to be "the application of the principles and methodology of modern science to problems of administration"<sup>4</sup> Scientific management does not and will not do anything on faith. Before any view is accepted, it's got to be proved that it is better than existing views of the time.

In discussing scientific management at any level, mention has to be made of its founding fathers as a continuing acknowledgement of their efforts in improving management principles and practices in the whole world. In this respect, this writer will mention Frederick Taylor (1856 - 1915). Taylor was an American who was acclaimed and is still known as the father of scientific management. He was of the view that the casual rule-of-the-thumb approach to management widely used in his days should be replaced by scientific study and analysis. He believed that science is an integral part of management. Frederick Taylor is very important in this paper because he performed the pig-iron experiment which bordered on time and motion study. He tried to decide what constituted a fair days job on the basis of an in-depth study of a particular job, rather than by estimation and conjecture. Taylor's pioneering efforts had major contributions from H.L. Gantt, F.B. Gilbreth, H. Emerson and others. With the mention of the pig-iron experiment it is clear that time and motion study is a scientific management study.

### **The Significance of Scientific Management to Libraries**

The significance of scientific management to libraries could be seen in its importance to industry. It is to improve production and distribution efficiency. This in the final analysis brings profit to the industry. Since libraries do not operate for the purpose of financial gain, it has been argued by some librarians that scientific management cannot and need not apply to libraries. This argument is however, weakened by the fact that most libraries are a part of other government and public service organizations and share with them the

responsibility for giving the tax payers a maximum return of service for each Naira expended. Sometimes, Librarians may be called upon to justify the existence of their libraries. The Librarian can only use the scientific management principles to demonstrate operational efficiency and not production efficiency as in the case of companies. For example, a Librarian who requests for more money should justify this request. This justification is not possible without the use of facts and figures. Scientific management can help in developing a factual argument for the additional fund. Finance Allocation Committee are always more impressed by quantitative factual justification than by guesstimates.

The question of scientific management application to libraries is a 'sine-qua-non' and a non-debatable issue. This is because the very substantial part of library work consists of repetitive, mechanical routines that lend themselves readily to quantitative analysis. Dougherty and Heinritz are of the opinion that as much as 70 to 90 percent of all current library tasks consists of such routines. These include ordering, cataloguing, card filing, shelving, circulations and its constituent steps. It is safe to say that majority of library tasks are quite repetitive and measurable, and if this is the case, scientific management can be employed to improve routine or operational efficiency. Scientific management is also a useful tool in library personnel and management. Work analysis, for example is the bedrock of modern job classification. This in turn produces good job schedules and descriptions. Succinctly put, scientific management makes it easy for a person to improve production or service by simple improvements such as:

- (i) re-arrangement of work-area,
- (ii) altering the sequence of steps for performing a job,
- (iii) hatching of work (i.e. grouping of several units into one),
- (iv) addition or subtraction of personnel.

### **Choosing an area for study**

In selecting an area for study, this analyst has considered the areas enumerated by R.M. Dougherty which are:

- (i) Frequently performed jobs,
- (ii) Repetitious job;
- (iii) Jobs requiring frequent movement of people and equipment;
- (iv) Jobs with bottlenecks.

One sees that the circulation area selected for study in this paper is an embodiment of the four areas enumerated above. This is because the circulation of library materials is a frequently performed job; it is repetitious; it requires frequent standing and sitting, removal and replacement of loan materials e.g. drawing the trolley of returned books to the shelves etc; and finally it could be a job with bottleneck since circulation is connected with other services in the library. A book cannot be circulated without the necessary technical processing, labelling, lettering etc. which in themselves could constitute a bottleneck. The user does not know or is not concerned about all these preliminary steps to circulation. All he (reader) wants is the book and once he



cannot get the book to borrow, the library is inefficient.

The amount of time saved for a frequently performed job can be multiplied by high frequency of operation and makes the total time saved very substantial. For example, if a library circulates 60,000 physical volumes a year, and if by some simple flow of work improvement, the library is able to reduce the average time needed for some steps by one minute per volume; there will be an annual saving of 60,000 minutes or 1000 man hours or about 42 days each year. Other high frequency jobs are searching, typing of book orders, shelving etc.

When a job is described as repetitious it is meant that steps recur each time the task is performed. Book charging and discharging top the list of repetitious and frequently performed jobs in libraries. Jobs requiring frequent movement of people and equipment do not refer to long distance movements only, but also short and unnoticed distances. These short distances when multiplied by high frequency will equal long distances. This explains why some librarians get tired after a day's job and cannot see why this is so since they never carried, pulled or pushed. This type of study is able to reveal what great distance any library worker could cover in the performance of his duties. This great distance may run into tens of kilometres in a working month like administration, accounts, transport office, etc. of the organization. Library messengers are better experienced in confirming this. Jobs requiring frequent movement of people and equipment are analysed in order to decide the following:

- (i) Where to locate materials and equipment needed for the operation of the task.
- (ii) Placement of related library routines to reflect the natural flow of work and thereby minimize the total steps.
- (iii) Optimum physical arrangement between sections.

There should be a break-down of the work-flow in jobs with bottlenecks, to see which of the procedures constitute the problem. For example, the lettering of a call number on the spine, which is a sub-professional task and a pre-requisite for circulating the book could be a serious bottleneck to the user just the same way as the delay caused by non-cataloguing of the book. Anything that does not make the reader use the book is a bottleneck that should be looked into.

### Defining the Problem

Before making any management study and more specifically time and motion study there must be a problem. The problem has to be defined intelligently in relation to the overall objectives of the library. The criteria for study is bound to change as soon as the objectives of the library change. This analyst is making this study to satisfy some of the objectives of the NTTC library which are easy accessibility to, and the effective and maximum use of library resources. The problem identified in this regard is the usually long queue at the loan desk which makes our small circulation area crowded during peak periods. Books cannot be 'maximumly' circulated with this kind of problem.

### Data Gathering

Like in any type of study or experiment, data should be gathered to determine the ingredients of the study.

Without data, there can be no results. Poor data gathering gives very unreliable results and the study is better not done at all than to give an unreliable, inconclusive result. In motion study, data should be gathered to determine the constituent steps of the job while in time study data determines the time required to perform each element.

### Analysing the Present Procedure

To analyse the current method in use, the analyst must ask the following questions:

- (i) Why is the job performed?
- (ii) What is the purpose of the steps determined for the job?
- (iii) Where is the job performed? or could there be a combination of service points?
- (iv) When should the job be done? could it be done at any other time to a better advantage?
- (v) Who should do the job? could it be done by a less qualified person or a more qualified person? (One needs to distinguish between professional and non-professional duties here)
- (vi) How is the job done? or How it might be done better?

### Development of an Improved Procedure

To develop an improved method, the following approaches should be religiously followed:

- (i) eliminating routine as a whole or all unnecessary operations;
- (ii) combining operations where necessary;
- (iii) changing the sequence of operation (i.e. the order of steps);
- (iv) changing the operator if necessary;
- (v) simplifying operations.

In trying to develop a new method for charging, discharging and renewals of the NTTC library books and non-book materials, the above approaches have been followed and they are going to be treated one by one as they affect the NTTC library.

### Eliminating Unnecessary operations

In the former method of discharging books in the NTTC library, names of borrowers are filed within the date-due record. This means that when a borrower presents a book for return, the attendant will first check the date on the date-due label and then he (attendant) will ask for the name of the borrower. This second step of asking for the name of the borrower has to be eliminated. It is discovered that time spent in asking and answering of names seems to be enough to discharge a book, more so when the borrower murmurs his or her name inaudibly. The second step of name-asking has to be replaced by arranging book cards according to accession numbers within the date-due guides. Since no two volumes bear the same accession number, and since the accession number is a number that reveals the identity of any particular volume even in a title with so many copies in the library; the accession number is better used than the call number. Many books on the same subject by the same author or the same "first three letters" of the authors will have the same call



number. Time wasted in knowing which is which could be usefully spent on other steps.

Now, when a book is presented for discharge, it is the accession number that is checked and whatever bookcard that bears the accession number of the book will be pulled out together with the reader's ticket. The time saved in the modification of this step is substantial.

### Combining operations

In some University Libraries, charging and discharging are carried on separately, partly because of the separate entrance and exit doors and partly because of the population of students that use the library. In the NTTC library, these two activities are combined and carried on one table and by one attendant/assistant. There is also a combination of students, staff and special users' borrowing on the same loan's table. Each category of readers has its own tray.

### Changing the Sequence of Operation

This is the re-arrangement of the sequence in which a job is performed and this could yield substantial saving or increase operational efficiency. In the Reserve Book Service, the ledger record may soon give way to request slips to forestall the cleverness of fraudulent students in the art of giving fictitious names and false description of books borrowed to circumvent the library borrowing rules. Also the practice of students writing loan information in the register has been discontinued for the same reason.

### Changing the Operator

It is said that a job that can be performed with less skill or training than the present operator should be re-assigned to the less skilled person, whilst the one that ought to be performed by a more skilled worker than the present operator should also be re-assigned to the more skilled person. This involves the distinction between professional and non-professional duties which remain controversial in libraries. In the NTTC library, there are more attendants than assistants. As a result charging and discharging work are given to the less qualified attendants. Draft cataloguing or pre-cataloguing duties are given to the Assistant Library Officer to give the cataloguer a breathing space in her duties.

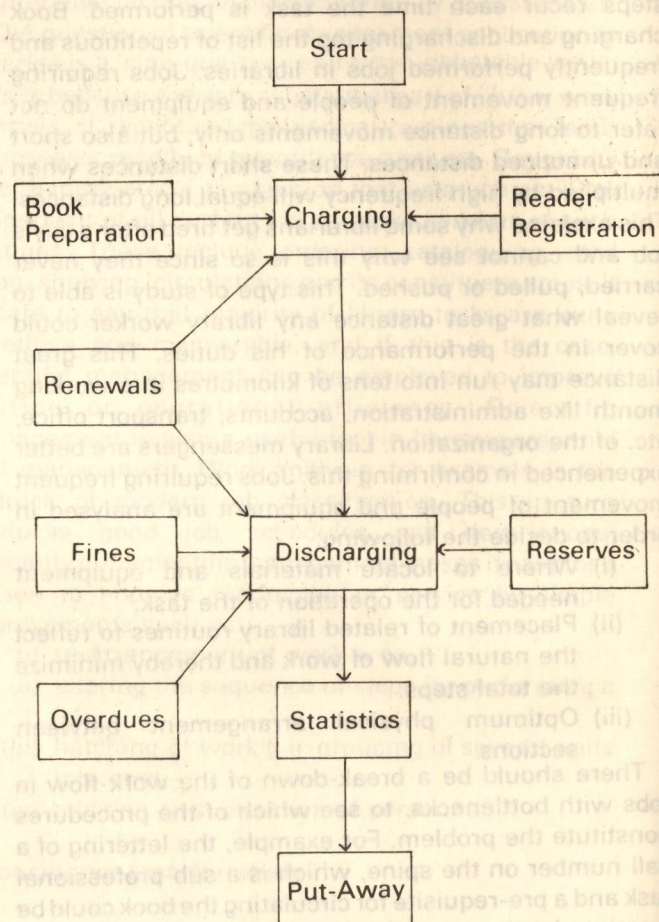
### Study Observations in the Circulation system of the NTTC Library

This time and motion study analysis was spanned over a period of four weeks in the month of May, 1981. This month is the peak period of library use for the examination - oriented students of this College. A week was devoted to a particular operation. A total of four operations were studied and these were: charging, discharging, renewal and reservation. With human efforts nothing is perfect. The analyst utilized the services of a youth Corper who recorded the observation and time. Other raw materials used for this study were the library staff, students and lecturers and last but not the least are the library books. This writer does not lay claim to any total accuracy peculiar to computers, the

study is only intended as a useful guide to those who have interest in making a similar study on any aspect of library operations, be it cataloguing, classification, book ordering, binding, labelling and a host of others.

### NTTC Circulation block diagram

A block diagram has been described as "a graphic representation of a series of operations, processes or sub-processes that collectively comprise a system"<sup>5</sup>. In other words a block diagram defines in graphic form, the scope and extent of a particular system.



Block diagram of the NTTC circulation system showing appendage of sub-processes.

### The Flow diagram

The flow diagram is a graphic view of a work area in which there is the path or movement of work or the flow of materials. It is usually called the 'flow of work' diagram. Motion study is concerned with the constituents of flow of work.

### Flow process chart for charging a book (NTTC)

| Step | Description of events   |
|------|---|
| 1    | Assistant sets the date machine (applicable to the first borrower for the day). |
| 2    | Reader presents book.   |
| 3    | Assistant asks for ticket and ID Card.  |
| 4    | - checks ticket and ID Card   |
| 5    | - opens the book and removes book card  |



|    |  |
|----|--|
| 6  | Assistant stamps the book card.  |
| 7  | - stamps date-due label on book.   |
| 8  | - gives book card to reader for signature  |
| 9  | - inserts book card (bc) in reader's ticket (RT)   |
| 10 | - gives book to the reader.  |
| 11 | - files book card and reader's ticket by date due and in the accession number order (remember accession number order replaces name order). |

#### Flow process Chart for discharging a book and collecting overdues

| Step | Description of events                                 |
|------|---|
| 1    | Reader presents book                                  |
| 2    | Assistant opens book                                  |
| 3    | - checks date - due                                   |
| *4   | - asks for reader's name (eliminated)                 |
| *5   | - checks date-due file for reader's name (eliminated) |
| 6    | Assistant brings out BC + RT.                         |
| 7    | - checks RT for reservation                           |
| 8    | - removes bc from RT.                                 |
| 9    | - cancels date-due stamped on bc.                     |
| 10   | - puts bc in book pocket (bp).                        |
| 11   | - returns RT to the owner                             |
| 12   | - places book on trolley for shelving.                |

#### Collecting over-due fine

|   |  |
|---|--|
| 1 | Assistant calculates amount of money owed. |
| 2 | Assistant collects money from reader       |
| 3 | - issues receipt for money paid            |
| 4 | - submits payment to the Account's office  |

#### Reader unable to pay

|   |  |
|---|--|
| 1 | Assistant seizes RT.   |
| 2 | - put reader's name in the register  |
| 3 | - circularizes the list of debtors.  |
| 4 | - submits list of debtors to Librarian.  |
| 5 | - Librarian sends the list to the College Accountant.                            |
| 6 | - College Accountant deducts money from readers monthly or any other allowances. |

#### Flow process chart for renewals:

The formula  $R = D + C$  explains that Renewal (R) is a combination of both the Discharging (D) and Charging (C) operations. Therefore all the steps under discharging have to be followed up to step 10 and steps 1 - 5 under charging may be ignored.

#### Flow process chart for reservation:

| Step | Description of event                            |
|------|---|
| 1    | Reader wants a book that is on loan.            |
| 2    | Assistant gives reader reservation form.        |
| 3    | Reader fills reservation form.                  |
| 4    | Assistant checks when the book is due.          |
| 5    | - files the relevant portion of the form.       |
| 6    | - puts a notice on the current borrower ticket. |
| 7    | - files reservation form with the others.       |

#### Book available

|   |  |
|---|--|
| 1 | Assistant notifies reader on the notice board.         |
| 2 | Reader presents notification slip.                     |
| 3 | Assistant looks for the book on the reservation shelf. |
| 4 | - follows steps 1 - 11 in charging operation.          |

#### Making a Time Study

Time study could be carried out in a library with an ordinary wrist watch. The watch should have a clearly visible second hand. For jobs that require more precise timing, e.g. in industry, the stop watch is the standard thing to use.

The job to be timed has to be divided into elements. Every effort should be made to keep the time of each element as short as possible, as observations of long duration tend to become inaccurate. Constant elements should be separated from variable elements. Constant elements are those elements that do not experience time fluctuation from cycle to cycle (i.e. mechanized processes) and they should be distinguished from those that experience time fluctuation (i.e. manual processes).

When selecting the person to be timed, it is always sensible to time somebody that regularly works at a normal pace rather than either the fastest or the slowest worker. This eliminates suspicion in the outcome of the timing.

When recording the time, the watch must run continuously and the recorder should be aware of 'foreign elements'. A foreign element is one that does not occur regularly in a cycle, e.g. a reader dropping his ID card while presenting it to the library assistant. Any side attraction could be a foreign element, e.g. unusually long exchange of greetings between the reader and the library assistant. Foreign elements may be ignored when timing if they infrequently happen in the cycle of an operation.

#### Rating the work

'Rating the worker' is a procedure devised by industrial time analysts to determine what constitutes a 'Normal Time'. A worker under observation tends to work faster or slower than he will normally work because of nervousness. This is why normal time



should be determined when rating an employee. Normal time is the time that will take a qualified person working at normal pace and using a standardized method to perform a job. The rating process consists of adjusting the observed speed to the time the analyst considers "Theoretical - Normal". This adjustment is subjective but acceptable because it is realized that rating cannot be carried out with mechanical precision.

The formula for computing normal time according to Dougherty<sup>7</sup> is:

$$NT = OT \times RF$$

i.e. Normal Time (NT) = Observed Time (OT) x Rating Factor (RF) OT, is the time observed for doing a job and RF is the analyst's judgement of what is considered "theoretical normal" rating. RF is expressed in percentage. If the analyst feels that the worker is fast, he (worker) will be given a rating of above 100% and if the worker is slow, he will be given a rating of below 100%.

For Example:

$$OT = 2.5 \text{ minutes}$$

$$RF = 1.25 \text{ (This is a rating of 25\% above 100\%)}$$

$$\therefore NT = 2.5 \times 1.25 \\ = 3.1 \text{ minutes}$$

### Conversion of Normal Time to Standard Time

It is necessary to convert normal time to standard time in order to know the standard output of a worker in a given day. If the standard time for discharging a book is 2 minutes, it is expected that a committed and devoted worker will discharge 240 books in an eight-hour-duty day.

Conversion Formula is:

$$ST = NT \times \frac{100}{100 - A}$$

$$\text{i.e. Standard Time (ST) = Normal Time (NT) } \times \frac{100}{100 - \text{Allowance (Break)}}$$

A worker's allowance should be expressed in a percentage of the total work-day which consists of 480 minutes in an eight-hour-day.

Before proceeding to convert normal time to standard time, the break allowance must first be expressed in a percentage of the total working minutes for the day.

e.g.

$$\text{Break Allowance} = 30 \text{ minutes}$$

$$\text{Daily duty minutes} = 480 \text{ minutes.}$$

$$\text{Percentage of break allowance} = \frac{30 \times 100}{480} \\ = 6.25\%$$

### Conversion of NT TO ST

$$ST = NT \times \frac{100}{100 - A} \text{ where } NT = 3.1$$

$$ST = 3.1 \times \frac{100}{100 - 6.25}$$

$$= 3.1 \times \frac{100}{93.75} \\ = 3.3$$

Barnes states that "for light work where the operator works eight hours per day without rest periods 2 to 5% (i.e. 10 - 24 minutes) per day is all the average worker will use for personal time"<sup>6</sup>

### Value of Time Study

Time study can be used to:

- (i) determine time standards;
- (ii) establish fair and reasonable performance standards;
- (iii) calculate the cost of a system;
- (iv) gauge employees performance so as to reward the employee for above standard performance and to train those performing below standard or take disciplinary action against them.

### Time readings for charging. (All readings in minutes)

| Date   | No. of volumes Charged* | Time (old method) | Time New method | Average time/volume |
|--------|-------------------------|-------------------|-----------------|---------------------|
| 4/5/81 | 10                      | 25                | -               | 2.5                 |
| 5/5/81 | 10                      | -                 | 20              | 2                   |
| 6/5/81 | 10                      | 24                | -               | 2.4                 |
| 7/5/81 | 10                      | -                 | 22              | 2.2                 |
| 8/5/81 | 10                      | 24                | -               | 2.4                 |
| 9/5/81 | 10                      | -                 | 19              | 1.9                 |

### Time readings for discharging. (All readings in minutes)

| Date    | No. of volumes Discharged* | Time (old method) | Time New method | Average time/volume |
|---------|----------------------------|-------------------|-----------------|---------------------|
| 11/5/81 | 10                         | 15                | -               | 1.5                 |
| 12/5/81 | 10                         | -                 | 12              | 1.2                 |
| 13/5/81 | 10                         | 16                | -               | 1.6                 |
| 14/5/81 | 10                         | -                 | 11              | 1.1                 |
| 15/5/81 | 10                         | 20                | -               | 2                   |
| 16/5/81 | 10                         | -                 | 12              | 1.2                 |

### Time readings for renewals

| Date    | No. of volumes renewed* | Time (old Method) | Time New method | Average time volume |
|---------|-------------------------|-------------------|-----------------|---------------------|
| 18/5/81 | 10                      | 50                | -               | 5                   |
| 19/5/81 | 10                      | -                 | 45              | 4.5                 |
| 20/5/81 | 10                      | 45                | -               | 4.5                 |
| 21/5/81 | 10                      | -                 | 38              | 3.8                 |
| 22/5/81 | 10                      | 40                | -               | 4                   |
| 23/5/81 | 10                      | -                 | 35              | 3.5                 |

\*For the purpose of this study only.



## Time readings for Reservation

| Date    | No. of volumes reserved* | Time (old method) | Time (New method) | Average time/volume |
|---------|--------------------------|-------------------|-------------------|---------------------|
| 25/5/81 | 10                       | 50                | -                 | 5                   |
| 26/5/81 | 10                       | -                 | 42                | 4.2                 |
| 27/5/81 | 10                       | 48                | -                 | 4.8                 |
| 28/5/81 | 10                       | -                 | 40                | 4                   |
| 29/5/81 | 10                       | 46                | -                 | 4.6                 |
| 30/5/81 | 10                       | -                 | 35                | 3.5                 |

\*For the purpose of this study only.

## Conclusion

Time and motion study is seen as a scientific management study intended to improve work procedures resulting in the achievement of organizational goals. In order to make time and motion study, an area for study must be chosen, problem defined, data gathered and the method being studied is analysed into elements. The elements must also be timed. This study is capable of determining standards of procedure; establishing reasonable performance standards; calculating the cost of a system, and gauging employees performance.

In the circulation system of the NTTC library studied, it was discovered that some cumbersome elements were eliminated and in some cases modified and the following average, time savings per volume obtained when the old and new methods were compared:

- (i) Charging - .4 minutes or 24 seconds
- (ii) Discharging - .5 minutes or 30 seconds
- (iii) Renewals - .6 minutes or 36 seconds
- (iv) Reservation - 2.4 minutes or 144 seconds.

It could be agreed that the above savings in time is substantial and can reduce the expense of operating this aspect of library operations in terms of time and personnel. It is therefore being suggested to librarians of various grades to please try this type of study in their multi-dimensional operations in libraries; be it in

cataloguing, classification, acquisitions, reference, and even shelving. The intention is generally to cut down considerably the cost of running a library service without sacrificing quality.

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