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Analysis of Processing Times of Selected Quantity Food Production Formulas

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To the Graduate Council:

I am submitting herewith a thesis written by Vivian Sue Connelly entitled "Analysis of Processing Times of Selected Quantity Food Production Formulas." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Management Science.

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To the Graduate Council:

I am submitting herewith a thesis written by Vivian Sue Connelly entitled "Analysis of Processing Times of Selected Quantity Food Production Formulas." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Institutional Administration.

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ANALYSIS OF PROCESSING TIMES OF SELECTED QUANTITY FOOD PRODUCTION FORMULAS

A Thesis

Presented to

the Graduate Council of

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

Vivian Sue Connelly

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ABSTRACT

The relationship of recipe processing time to number of servings, and pan size to number of servings was studied. These relationships are a prerequisite to the development of standard times for production tasks. Two recipe processing steps, panning pork chops and panning and dredging meat cubes were selected; the physical conditions influencing the performance of the steps were identified and controls defined. The variables were 100, 300, 500 and 700 servings and two pan sizes, counter pans (20 x 12 x 2-1/2 inches) and bun pans (18 x 26 x 3/4 inches).

Time required to prepare the processing steps varied with the number of servings and cooks. The variation was not proportional, thus conversion factors were determined. Specific standard times for the variables, that is, number of servings, pan size and cook were established. A regression model was plotted and data curves were established.

Success in setting time standards for recipe processing steps of any food service system is dependent on standardized recipes and production units where correct work methods are defined and practiced.

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CHAPTER I

INTRODUCTION

High labor cost, increased production demands, and decreased availability of qualified personnel make more effective and efficient utilization of manpower resources essential in today's food service industry. This is especially true in most hospital food service where labor is the greatest single expenditure. The trend in recent years of increasing food prices and labor cost make it essential that every effort be made by management to take advantage of all available technology to control the utilization of all dietary resources.

Time standards could profitably be utilized in the food service industry for production schedules and operational analysis and control. Work measurement provides a means of gathering factual information regarding human activity. Two industrial engineering approaches to work measurement are through time study and predetermined motion times (Niebel, 1967).

The use of quantitative measurement of labor time provides food service management with supportive data for making decisions concerning food production (Brown, 1969). Labor standards are a factor of food production costs, in that labor, raw food, and overhead factors constitute total production costs, and these standards are as fundamental to food service operations as to the operation of any manufacturing enterprise or business.

The dietitian must control the functions of all parts of the dietary system so that overall performance of the entire department is at the optimum. The use of data processing systems have provided quick and efficient tools for accomplishing this goal, thus making it possible for the development of guidelines for decisions by management. These decisions then are based on scientific information and methods of management rather than experience and intuition by the individual (Tuthill, 1971).

With the establishment of production time standards and the use of the computer, dietary management can be relieved of many routine decisions. To accomplish this goal, menu item analysis, data concerning production times and individual employee skill levels (Sager et al., 1968) would need to be included to optimize the utilization of personnel scheduled for work on any one day. As an example, the skill level of a trained cook is not used to an advantage in shaping meat balls once the mixture is prepared.

The production function in most hospital food service operations perform three distinct types of activities: (1) collecting the ingredients required to prepare a particular menu item; (2) measuring amounts of each ingredient appropriate for the quantity of the menu item to be prepared; and (3) operation on various ingredients, individually or collectively and the combining of them at the appropriate times under specific conditions (Konnersman, 1969). If a centralized material handling system is used by the dietary department, all weighing, measuring and counting is done by one person, and the ingredients then are

delivered to the cooks. The preparation of production schedules for the kitchen operation then becomes a simplified process, for it encompasses only the cooking operation.

Horizontal scheduling techniques (Blaker, 1970) are gaining popularity in hospital food service operation. This scheduling technique divides work into tasks with different persons being responsible for certain tasks in the preparation of all items. The processing of a recipe depends on the tasks and/or processing steps that are performed in its preparation. To accomplish the preparation operation, a product must be scheduled through the various work centers where the processing steps are performed. The characteristics of food present another major factor in production scheduling, for food quality changes constantly and at different rates for each food. Production scheduling becomes a complicated and scientific procedure with standard processing times a necessity.

The purpose of this study was to estimate, through the use of elemental times, the relationship of time to number of servings and number of servings to pan size of selected recipe processing steps for food production formulas used in quantity food production.

CHAPTER II

REVIEW OF LITERATURE

Time standards are essential for effective management and control of all production operations. This criteria is fundamental to manufacturing, commerce and trade as well as food production. According to Niebel (1967) time is a common denominator from which all elements of cost may be evolved. Time standards provide management with specific labor costs that can be used for price setting, work scheduling, and plant and production-line layout planning. This criteria enables management to predict during the planning stage the labor time needed for development of a new product. This allows for a comparison and evaluation of the present method and the proposed change.

Appraisal is another area in which time standards serve as a useful tool. Time standards provide the bases for objective evaluation of performance of personnel, machines, work centers and departments (Rogers, 1965).

In addition to serving as a common denominator for comparing cost, methods and performance, time standards aid management in budgetary control and for balancing the work force with production demands. Neibel (1967) also indicated that time standards improve production control, aid in improving personnel standards, and simplify the problems of management.

I. TIME STANDARDS

The standard time for any given operation is the time required by a specific operator to perform a job, according to Krick (1966). Barnes (1968), defined a time standard for a given operation as the standard number of minutes that a qualified, properly trained, and experienced person should take to perform a specific task when working at a normal pace.

Standard data are detailed and orderly presentation of all time facts of any given operation. These data are the result of summarizing and combining a number of stopwatch time studies to arrive at a table of time values for the full range of a given operation (Cloud, 1961). These tables are compiled to allow the measurement of a specific task to be done without the necessity for a timing device at each repetition of the operation. Selected standard data methods in current literature are Motion Time Analysis (MTA) (Maynard, 1956), Work Factor (Barnes, 1968), Method Time Measurement (MTW) (Crossan *et al*., 1962).

Motion Time Analysis (Maynard, 1956), developed by Seuger, is based on the physiological theory that the mechanism of the human body may be considered a chemical engine. As Seuger described the theory, each action that the body physically performs is the result of some chemical reaction which takes place within the body. Because chemical reactions take place at a constant temperature, the time for physical body reactions also should be constant within narrow limits; therefore, the time required to perform basic motions tends to be constant for different individuals. Time then is a function of method and if the

correct method is followed by any operator, he will more likely achieve the standard that was established for that method. The use of Motion Time Analysis (MTA) has been restricted by the patent maintained by its founder.

The Work Factor System, the trademark of the Work Factor Company, was developed by Quick, Duncan and Malcolm (Barnes, 1968). This method theorizes that the four major variables of body member, distance, manual control, and resistance determine the performance time of manual motions.

Methods Time Measurement (MTM) is a system of motion-time standards developed by Maynard, Stegemesten and Schwah (Maynard et al., 1962). It divides manual operations into the basic elements required to perform each operation. It then sets predetermined time standards for each element according to the physical conditions involved in the motion performed and the nature of the environment in which it was made.

Master Standard Data (MSD), developed by Crossan and Nance (1962), is described as a group of MTM motion times adjusted to indicate the time required for an operator working at a normal pace to complete a segment of a task. Its application procedure is similar to MTM. The effect of control on the time required to perform the fundamental motions and the ability to perform them simultaneously is emphasized. As more control is required, more time is needed to perform the basic motions.

Time and Motion study (Barnes, 1968) has steadily improved since the 1920's until today it is regarded as a necessary tool in the effective operation of business and industry. Neibel (1967) stated that,

although time and motion studies are primarily used in the manufacturing industries they are equally important in any area where the combined effects of men, materials, and facilities are used to fulfill an objective.

Food service administrators are beginning to investigate motion and time study techniques to determine if implementation of scientific practices will yield increased productivity with improved utilization of resources.

II. APPLICATION OF TIME STANDARDS

Today the food service industry is searching for a systematized method of measuring and evaluating job performance. The successful application of standard data and predetermined motion techniques to help management predict production times of specific work function is noted (Montag et al., 1964; Beach et al., 1969; Waldvogel, 1967). Montag et al. (1964) used the predetermined motion-time system MSD to investigate bake shop activities. Master Standard Data were reliable for predicting production time for processing baked custard and yeast rolls; however, the technique was too time consuming for economic application. The successful application of Method Time Measurement in determining entree serving time was reported by Beach et al. (1969), whereas Master Standard Data were found by Waldvogel (1967) to accurately predict the elemental breakdown of three different entrees.

Still another method was tested by DeMarco et al. (1967). In their study, the problem was approached by determining production

manpower requirements by dividing recipe instruction into six segments; assembly time, preparation time, panning time, cooking time, holding time, and portioning time. A time standard was constructed for each recipe segment and for each individual recipe.

Brown (1969) used stopwatch studies to quantitatively measure labor. Tasks were segmented into clearly defined pieces of work in food production called modules of labor. The modules were developed on the bases of actual observation of work done in recipe preparation. Average time for each module of labor was established as a work standard. A similar method was used by Boor (1970) to determine the feasibility of setting standard times for six selected recipe processing steps in an ongoing controlled food production system.

The time relationship involved in preparing five different amounts of 15 selected recipes was investigated by Ivanicky et al. (1969). The results of the study were analyzed statistically by regression line models. Mathematical determination was made to predict the preparation time required for quantities of the recipes' elements; preparation, panning and cooking that were not studied.

The most recent technique reported in the literature for planning production schedules (Bloetjes et al., 1971) was the construction of a theoretical production model. To develop the production model, time studies, analysis of equipment and other preparation resources were recorded separately for each ingredient in the preparation of turkey salad.

Research reported has dealt with isolated applications of time and motion studies. All studies conducted to date indicate a repeated

occurrence of like elements within different production methods and all investigators have reported the feasibility of developing a universal data code for food production. Brown (1969), Ivanicky _et al_. (1969), and DeMarco _et al_. (1967) conducted studies to develop input data for computer-assisted management.

The survey of the literature has not indicated a simple and precise method of collecting data to enable food service administrators to plan production successfully.

CHAPTER III

PROCEDURE

The relationship of recipe processing time to number of servings and pan size to number of servings was studied. The processing steps timed were those appearing most frequently in the six week cycle menu used at the 1500 bed hospital where the research was conducted. A processing step was defined as one food preparation operation that was found in a number of different recipes. Two processing steps were investigated. Step one was the panning of piece meats and step two was the panning and dredging of cubed meats. Pork chops were timed for step one and beef, veal and lamb cubes were used for step two. These meat items appeared on the menu frequently and in sufficient quantities to allow replication.

I. SELECTION OF LAYOUT, EQUIPMENT AND PERSONNEL

All meat items were prepared in the central meat processing area of the hospital. The meat processing unit then issued meat products to the ingredient assembly unit, here the meat was consolidated with other recipe ingredients. The consolidated recipe components then were delivered to the production work centers. The layout of the production center in which the processing step was performed was that used in the daily operation of the production area (Appendix A, Figures 1 and 2).

Two sizes of pans were used for the timing of each of the two processing steps. Stainless steel baking and counter pans, 20 x 12 x 2-1/2 inches, were selected. This was the pan size most frequently used when menu items are cooked and served directly from the same pan.

Aluminum bun pans, 26 x 18 x 3/4 inches, the pan size most conventionally used for quantity food preparation was selected as the other pan. Other equipment used in investigation were identified in the description of each processing step. Further description can be found in the Federal Supply Catalog, C7300-1L, October, 1971.

Three cooks were selected for the study. Two of the cooks were those who routinely prepared all meat items for the hospital. At the beginning of the investigation, the third meat cook was on extended sick leave and the relief cook was selected to participate in the study. Although one cook was not a "regular" meat cook, the three cooks were considered equally skilled and all held the job description of a Wage Grade 8 employee, with the Federal Civil Service Job Classification of 7404 for cooks (Civilian Service Commission, 1968).

Normal work procedures as used at the hospital were timed; therefore, no special training was given. The work center layout was discussed with each cook to help to eliminate personal work habits.

II. METHOD OF STUDY

The two processing steps investigated were panning of chops and panning and dredging of meat cubes. One pork chop was considered a serving. One inch meat cubes were used for combination dishes, for

example, Irish Stew and Hungarian Goulash. Timing of all steps was conducted for 100, 300, 500 and 700 servings for each of two pan sizes. Each of the specified serving levels was considered a separate study and data were collected independently for each serving level. For example, 300 servings were considered as one study and the preparation of 300 servings was timed from one pork chop to the final preparation of the three hundredth pork chop. Time was done independently for each variable that involved number of servings.

For step one, panning pork chops, the chops were divided into batches of 100 servings and placed in stainless steel containers[1] and transported on a cart[2] from the central ingredient room to the work center. The cubed meat for processing step two, followed the same material flow as the pork chops with one exception. The meat was cut into cubes and packaged in plastic bags,[3] secured with string[4] in portions of 100 servings. The two processing steps used for the study were as follows:

Step One--Piece Meat: Panning

The work center was arranged according to Figure 1, Appendix A. The following tasks were repeated until all items were panned and placed in the pastry cabinet:

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[1]Federal Stock Number 7330-263-8504.

[2]Model Number 922-Z, Nutting Co., Rockville, Maryland.

[3]Federal Stock Number 8105-401-2010.

[4]Federal Stock Number 4020-233-5995.

1. The stainless steel container of pork chops was removed from the transport cart to the work surface.
2. The pork chops were removed from the stainless steel container and placed on bun pans[5] or counter pans[6] in single layers.
3. Each pan was sprinkled with salt and pepper.
4. As a pan was filled it was placed on a pastry cart.
5. The empty container was replaced on the transport cart and another container of meat was placed on the work surface.

Step Two--Cubed Item: Panning and Dredging

The work center was arranged according to Figure 2, Appendix A. The following tasks consisted of:

1. Cubed meat was transported in plastic bags which were removed one at a time from the transport cart. The string securing the bag was cut, and the cubed meat placed on three bun pans or three counter pans. The plastic bag was discarded in a waste receptacle, located in the work area.
3. Salt was distributed evenly over each pan of cubed meat.
4. Pepper was distributed evenly over each pan of cubed meat.
5. Flour was distributed evenly over each pan of cubed meat.
6. With a skimmer, each pan of meat was sprinkled with cooking oil and dredged.

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[5]Federal Stock Number 7330-633-8905.

[6]Federal Stock Number 7330-554-8905.

Timing for step one began when the cook placed the empty stainless steel container on the transport cart. The timing scheme was repeated until all food was processed and placed in the pastry cabinet and the last stainless steel container was placed on the transportation cart. The timing element within the timing cycle began when the cook touched the first food item and ended when each bun pan or counter pan was placed in the pastry cabinet.

For step two, timing of each element began when the cook first touched the plastic bag and ended when the last of the three pans containing 100 servings was placed in the pastry cabinet.

A decimal-minute stopwatch was used for collecting time data by the continuous timing method (Barnes, 1968). The stopwatch was accurate to a tenth of a second.

Data were collected by a Registered Dietitian who was familiar with the procedures of the controlled food service system. A trial run was performed with each of the three assigned cooks for each processing step by the recorder to gain experience in the use of the stopwatch. Readings were recorded on the Data Collection Sheet shown in Appendix B.

III. STATISTICAL ANALYSIS

The null hypothesis for the study was that there was no difference for processing time of 100 to 700 servings and that there was no difference in processing time when different pan sizes were used in the preparation. The null hypothesis was tested by analysis of variance for interactions between pan size and number of servings.

The experimental design was a fractionalized scheme as illustrated in Figure 1, Appendix B. The data were subjected to analysis using computer programs developed by Barr et al. (1971).

CHAPTER IV

RESULTS AND DISCUSSION

Stopwatch time studies were used to investigate the relationship of time to number of servings and number of servings to pan size of selected quantity recipe processing steps. The two processing steps were panning pork chops and dredging and panning meat cubes. Timing of all steps was conducted using 100, 300, 500 and 700 servings for each of two pan sizes. Each of the specified serving levels was considered a separate study and data were collected independently for each level.

The average times reported for each processing step are the average elemental time actually taken by the cook during the study. Cooks were carefully selected whose observed time would be considered normal time. Performance ratings were not applied to the actual time by the observer to compensate for variation in speed and effectiveness of the individual cooks during a specific time study. The three cooks were also considered treatments for the statistical analysis. Allowances for personnel, unavoidable delays and fatigue were not applied because they had not been established by the food service.

I. PROCESSING STEP ONE--PIECE MEAT: PANNING

The variable factors in the studies were number of servings to production time, pan size to production time and the cooks used in the studies (Table I). Other factors that caused variability in timing

TABLE I

AVERAGE PROCESSING TIME[a] FOR COOKS
FOR PANNING PORK CHOPS

	Cook A[c]		Cook B[c]		Cook C[c]	
Serving Level[b]	Bun Pan[d]	Counter Pan[d]	Bun Pan[d]	Counter Pan[d]	Bun Pan[d]	Counter Pan[d]
100 Servings	2.86	2.76	2.35	2.80	2.70	2.93
300 Servings	7.97	8.45	6.33	7.59	7.90	8.95
500 Servings	12.01	13.76	11.58	13.41	13.36	15.22
700 Servings	18.56	19.25	15.97	19.58	18.86	19.43

[a]Processing times are given in decimal minutes.

[b]Number of servings were significant at $P < .001$.

[c]Cook differences were significant at $P < .001$.

[d]Pan size was not significant.

elements were controlled, i.e., layout of work station, production and equipment used. An unforeseen variable became apparent to the observer as the studies were continued, that was the judgment of the individual cooks as to the number of pork chops placed in individual pans (Table II).

The more pans necessary to complete a study, the less the average processing time per pan. Fewer pork chops handled for the timing of an element resulted in a decrease in the number of manipulations per cycle. Increased manipulation of an item in processing also caused an increase in the time to perform that process as reported by Beach et al. (1969) and Boor (1970).

TABLE II

PROCESSING TIME DATA FOR PANNING PORK CHOPS

Serving Level	Total Study Time[a] (Minutes) Bun Pan	Counter Pan	Number of Elements[b] Bun Pan	Counter Pan	Average Time Per Element (Minutes) Bun Pan	Counter Pan
100 Servings	2.74	2.76	3	4	.91	.69
	2.97	2.53	3	5	.99	.51
	2.35	3.08	3	6	.78	.51
	2.66	2.93	3	6	.89	.49
	2.73		3		.91	
300 Servings	7.93	8.45	8	14	.99	.60
	8.00	7.59	10	13	.80	.58
	6.16	8.43	7	14	.88	.60
	6.50	9.46	6	15	1.08	.63
	7.90		8		.99	
500 Servings	12.01	13.57	13	22	.92	.62
	11.14	13.94	11	22	1.01	.63
	12.01	13.41	11	22	1.09	.58
	12.88	15.22	13	23	.99	.66
	13.83		14		.99	
700 Servings	18.00	19.25	18	31	1.00	.62
	19.11	19.24	22	32	.87	.52
	15.97	19.91	17	33	.93	.60
	19.13	19.43	19	31	1.00	.62
	18.58		19		.97	

[a]Number of studies for each serving level determined by fractionalized scheme (Figure 4, Appendix B).

[b]Number of elements also indicated the number of pans used for the timing cycle.

The number of pork chops laid per pan was at the judgment of the cook. When the smaller counter pans (20 x 12 x 2-1/2 inches) were used, there was a greater variation in the number of pans than when bun pans (26 x 18 x 3/4 inches) were used to lay the chops (Table II, page 18). It was observed that when the smaller pans were used there was a greater overlapping of the chops. Sufficient pans were provided for the studies; however, the cooks were aware of the shortage of pans for other operations in the kitchen and were conservative in their use of pans. The overlapping of pork chops affected the browning of the product and lessened the quality of the cooked product. From these observations made during this investigation, the bun pan would be more efficient than the counter pan for processing pork chops. There was a slight increase in average processing time for panning pork chops in counter pans as well as the lessening of quality of pork chops. Use of counter pans would also increase the amount of oven space for cooking, increase in space for transportation, and increase number of pans handled during the serving process.

When the collected time data were subjected to statistical procedures it was determined that number of servings, cook and pan size had a strong influence on the production operation. Number of servings and cooks were highly significant ($P < .01$, Appendix C, Table V). An analysis of variance by subgroup means was computed for the linear relationship between the two pan sizes and the serving levels (Appendix C, Table VI). There was a linear relationship for each of the pan sizes; therefore, a prediction equation for each pan size was necessary.

A statistical regression line model then was used for the analysis because it portrayed the relationship between production time and the number of servings. The dependent variable was time and the independent variable was the number of servings. The linearity of the relationship was determined by the equation of the form $y = a + bX$, where a is the y intercept and b the slope of the line. The best estimation of a and b was determined by means of the method of least squares. The standard time for panning pork chops in bun pans is equal to T = -.275 + .02586 number of servings. The slope of the line estimated the average increase in time per serving of pork chops. The standard error of estimation measured the standard deviations of the original data points about the regression line.

The relationship of time to number of servings was determined for each cook as illustrated in Appendix D, Figures 5 through 12. The predicted time for panning pork chops was more closely estimated for any given cook if regression models were computed from time studies in which he participated. The standard error of estimation for all cooks when pork chops were processed using bun pans was .037. When time to process 280 servings of pork chops was calculated by reading from the proper regression model, the time was 8 minutes and the deviation of less than half a minute (.296 minutes). With a deviation of this size it would be impractical and uneconomical to collect and maintain data for each cook for each recipe unless precise accuracy was necessary. Performance rating factors applied to actual processing times also compensated for differences in performance of individual cooks (Barnes, 1968) and would be necessary in the development of standard times for panning pork chops.

II. PROCESSING STEP TWO--CUBED MEAT: PANNING AND DREDGING

Increased production time for step two revealed that labor time decreased as the number of servings increased (Table III).

The variability for the individual time studies was affected by the state of the product when received in the production unit. Frozen commercial meat cubes were used for a number of studies. These cubes were allowed to thaw in the plastic transport bag. The amount of drip in the plastic bag was excessive and increased the difficulty of the processing operation. Difficulty in manipulating the plastic bag also was indicated by an increase in the average processing time for most studies where bun pans were used (Table IV). The two and one-half inch side on the counter pan provided a guide for the pouring of meat cubes into the pan. Other factors which were observed to produce variability was the degree of coating on the meat cubes and the distribution of cubes equally into three pans used to process each 100 servings.

There was a significant affect on time by number of servings (Appendix C, Table VII). The relationships were linear and regression line models were used to portray the relationship (Appendix D, Figures 13 through 20). The standard error of estimation was greater for processing step two than for processing step one. The variability of the average study times indicated that factors other than those measured in the study design were present. This was observed to be the difficulty in handling the product and the number of manipulations of the product.

TABLE III

AVERAGE PROCESSING TIME[a] FOR COOKS FOR PANNING AND DREDGING MEAT CUBES

	Cook A[c]		Cook B[c]		Cook C[c]	
Serving Level[b]	Bun Pan[d]	Counter Pan[d]	Bun Pan[d]	Counter Pan[d]	Bun Pan[d]	Counter Pan[d]
100 Servings	3.45	3.01	4.22	3.91	4.03	3.47
300 Servings	6.60	8.22	11.61	9.90	5.94	7.79
500 Servings	13.76	13.37	16.79	13.68	12.63	14.02
700 Servings	15.53	25.14	20.96	17.20	23.25	14.48

[a]Processing times are given in decimal minutes.

[b]Number of servings were significant at $P < .001$.

[c]Cook differences were not significant.

[d]Pan size differences were not significant.

TABLE IV

PROCESSING TIME DATA FOR PANNING AND DREDGING MEAT CUBES

	Total Study Time[a] (Minutes)		Number of Elements[b]		Average Time Per Element (Minutes)	
Serving Level	Bun Pan	Counter Pan	Bun Pan	Counter Pan	Bun Pan	Counter Pan
100 Servings	3.40	3.01	3	3	1.13	1.00
	3.50	4.17	3	3	1.17	1.39
	4.22	3.65	3	3	1.74	1.22
	4.00	3.47	3	3	1.33	1.16
	4.05		3		1.35	
300 Servings	7.21	8.22	9	9	.80	.91
	6.00	9.90	9	9	.67	1.10
	10.86	8.27	9	9	1.21	.92
	12.37	7.30	9	9	1.37	.81
	5.94		9		.66	
500 Servings	13.76	13.46	15	15	.91	.90
	16.53	13.27	15	15	1.10	.88
	17.04	13.68	15	15	1.13	.91
	13.40	14.02	15	15	.90	.93
	11.85		15		.79	
700 Servings	16.12	25.14	21	21	.77	1.19
	14.94	19.34	21	21	.71	.92
	20.96	15.06	21	21	1.00	.72
	15.48	14.48	21	21	.74	.69
	31.01		21		1.48	

[a]Number of studies for each serving level determined by fractionalized scheme (Figure 4, Appendix B).

[b]Number of elements also indicated the number of pans used for the timing cycle.

The preceding results and data imply that it is feasible to set standard times for variable processing steps in recipes provided the factors affecting variability are established and measured.

III. APPLICATION OF THIS RESEARCH

Time studies are made to establish the relationship between time and the prevailing conditions which can be analyzed for the best and most economical performance of an operation. In the production unit of a dietary department the recipe defines the operations. Since every recipe consists of number of work elements, each element can be timed and the allowed time of its performance established. Because many tasks are common to different recipes it is possible to establish standard times for a processing task. This then may be transferred to a variety of recipes that contain the processing step without additional studies.

The results of this study indicate that the time required to prepare a recipe varies with the number of servings and the size of the pan used for processing. In an ongoing dietary department, the number of servings prepared are adjusted daily to meet census requirements. The establishment of conversion factors facilitates such adjustments and are essential to the determination of chronological time of food production. Determination of "how long" it takes to process a recipe is essential to the function of controlling production, in that production control is based upon determining where and when the work will be done. When processing steps for standardized recipes are identified and time standards developed, the processing of a recipe can be correlated with the total production procedure at each work center.

The method presently investigated to establish conversion factors can be used for collecting data for all recipe processing steps and used as input data for computer programs. The application of such input data to computer assisted management reduces the repetitive judgments made by the dietitian. For example, the computer could calculate and print the starting time for each recipe in a day's food production schedule. Each menu item would be ready and served at its peak of freshness.

The derivation of a complete set of time data for all recipe processing steps is essential for determining labor standards and planning production schedules. Further investigation of processing times must be hypothesized and tested. Additional investigation of relationships of the size and texture of the product on the recipe processing steps are necessary to establish standard data.

CHAPTER V

SUMMARY

The efficiency of food service systems relies on scheduling adequate numbers of employees in a given time frame to accomplish a specified workload within a minimum amount of effort. The lack of precise data governing manpower requirements of food service systems results in food service administrators relying on subjective judgments to plan production schedules.

The relationship of recipe processing time to number of servings and pan size used in the panning of pork chops and the dredging and panning of cubed meat was studied. The physical conditions influencing the performance of the steps were identified and controls defined. Serving levels (100, 300, 500 and 700 servings) and two pan sizes (counter pans 20 x 12 x 2-1/2 inches and bun pans 26 x 18 x 3/4 inches) were tested. Continuous stopwatch studies were employed to gather time data. The null hypothesis was tested by analysis of variance for interaction between pan size and number of servings. Regression line models were used to portray the relationship between production time and number of servings.

The effect of cooks and number of servings had a significant effect on the average processing time for panning pork chops. The preparation time involved in the processing step panning and dredging meat cubes was significantly affected by the number of servings.

In addition, average processing time for the two pan sizes was affected by the number of manipulations and difficulty in handling the product.

It is feasible to set standard times for the processing steps defined in this study if the factors affecting average time of the work elements are identified. Labor required to prepare the processing steps evaluated in this study varied according to the number of servings. The variation was not proportional and conversion factors were utilized. Specific times for any number of servings, pan size and cook could be read from established regression line models.

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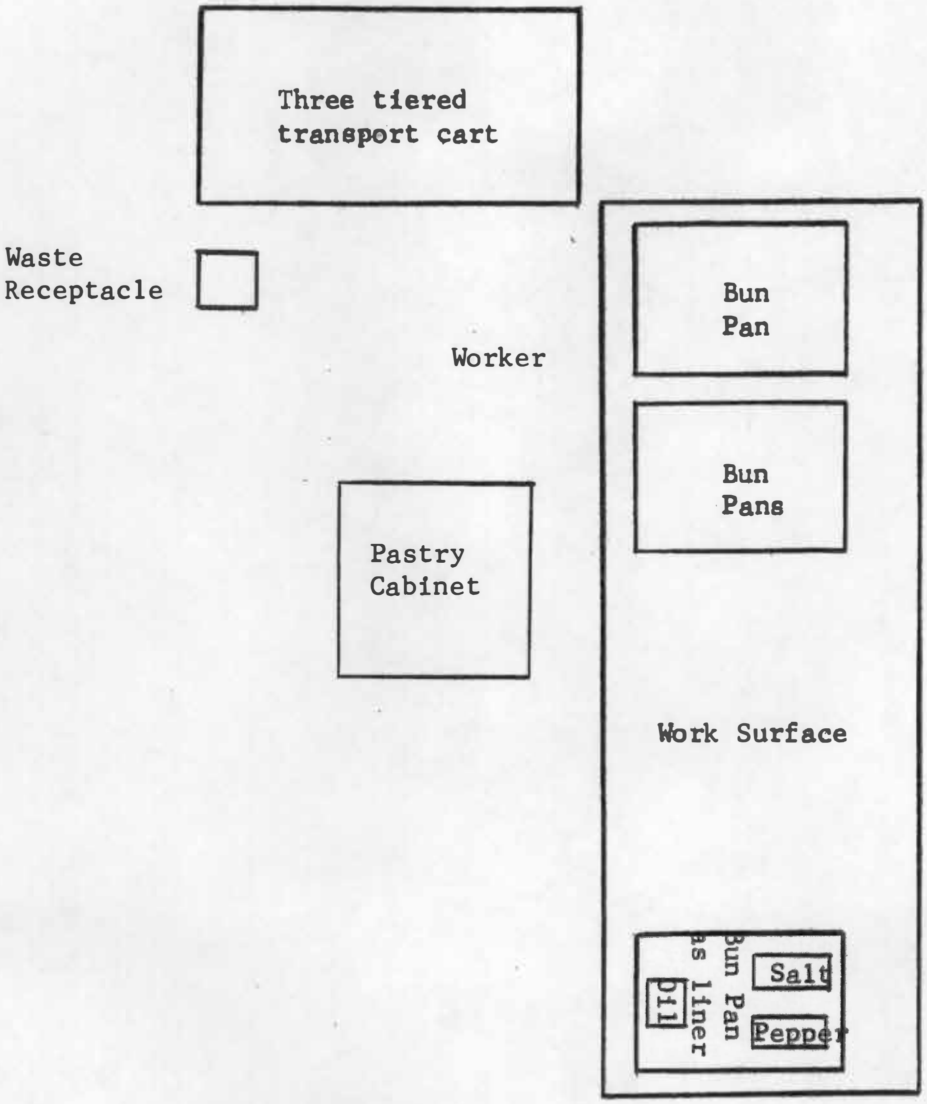
APPENDIXES

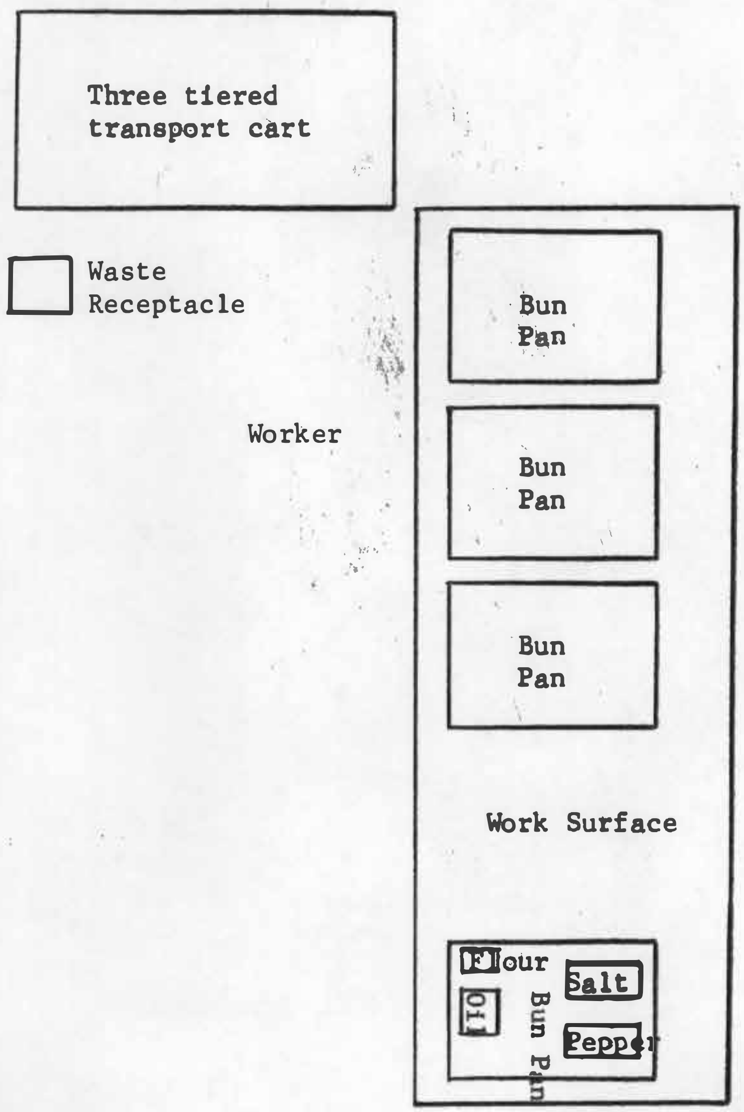
APPENDIX A

LAYOUT CONFIGURATIONS



Scale: 1/2 inch = 1 foot.

Figure 1. Layout configuration for step one, piece meat: panning.



Scale: 1/2 inch = 1 foot.

Figure 2. Layout configuration for step two, cubed meat: panning and dredging.

APPENDIX B

DATA COLLECTION SHEET AND STATISTICAL SCHEME

PROCESSING STEP			READING NUMBER			DATE	PAGE
PRODUCT						EMPLOYEE	
PAN SIZE						NUMBER OF PANS USED	
	TIME						
PAN NO.						NO. OF SERVINGS	NOTES

COMMENTS:

Figure 3. Data collection sheet.

Serving Level	100 Servings			300 Servings			500 Servings			700 Servings		
Cook	A	B	C	A	B	C	A	B	C	A	B	C
Panning Pork Chops Bun Pans (26 x 18 x 3/4 inches)												
		X				X	X				X	
Panning Pork Chops Counter Pans (24 x 12 x 2-1/2 inches)												
	X		X	X	X			X	X	X		X
Panning & Dredging Meat Cubes Bun Pans (26 x 18 x 3/4 inches)												
		X				X	X				X	
Panning & Dredging Meat Cubes Counter Pans (24 x 12 x 2-1/2 inches)												
	X		X	X	X			X	X	X		X

Empty cells denote replications of study serving level as performed by an individual cook.

Figure 4. Fractionalized scheme for collection of data.

APPENDIX C

TABLES

TABLE V

ANALYSIS OF VARIANCE OF STEP ONE--PANNING PORK CHOPS FOR TOTAL PROCESSING TIMES

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F
Total	34	1248.13		
Pan Size	1	10.32	10.32	12.58 ns
Number of Servings	3	1074.16	358.05	716.10 ***
Cook	2	7.99	4.00	16.60 ***
Pan Size-Number of Servings	3	2.93	.93	2.33 ns
Pan Size-Cook	2	1.64	.82	1.95 ns
Number of Servings-Cook	6	3.02	.50	1.19 ns
Pan Size-Number of Servings-Cook	6	2.53	.42	1.75 ns
Residuals (Error)	11	2.63	.24	

TABLE VI

ANALYSIS OF VARIANCE--LINEAR REGRESSION BY SUBGROUP

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F
Total	7	284.73		
Pan Size	1	2.65	2.65	66.25 ***
Linear (Number of Servings)	1	281.27	281.27	7031.75 ***
Pan Size x Linear	1	.64	.64	15.14 *
Residuals	4	.17	.04	

TABLE VII

ANALYSIS OF VARIANCE OF STEP TWO--PANNING AND DREDGING MEAT CUBES FOR TOTAL PROCESSING TIME

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F
Total	36	1643.96		
Pan Size	1	.79	.79	.039 ns
Number of Servings	3	1157.99	385.99	114.24 ***
Cook	2	14.93	7.47	.70 ns
Pan Size-Number of Servings	3	2.82	.94	.06 ns
Pan Size-Cook	2	40.25	20.12	1.35 ns
Number of Servings-Cook	6	20.24	3.37	.22 ns
Pan Size-Number of Servings-Cook	6	93.78	15.63	1.47 ns
Residuals (Error)	13	138.38	10.64	

APPENDIX D

REGRESSION LINE MODELS

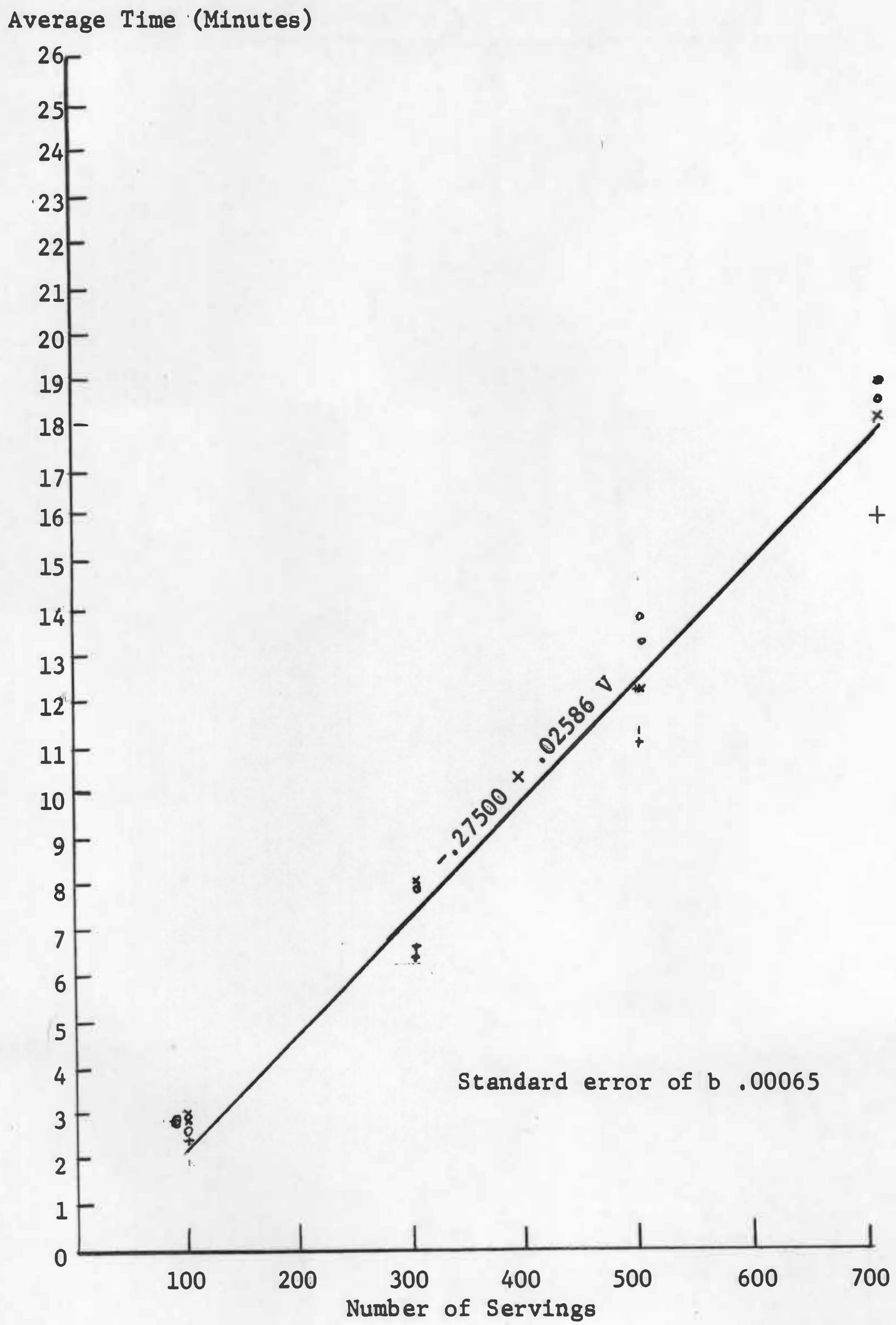


Figure 5. Processing time data for panning pork chops on bun pans (26 x 18 x 3/4 inches).

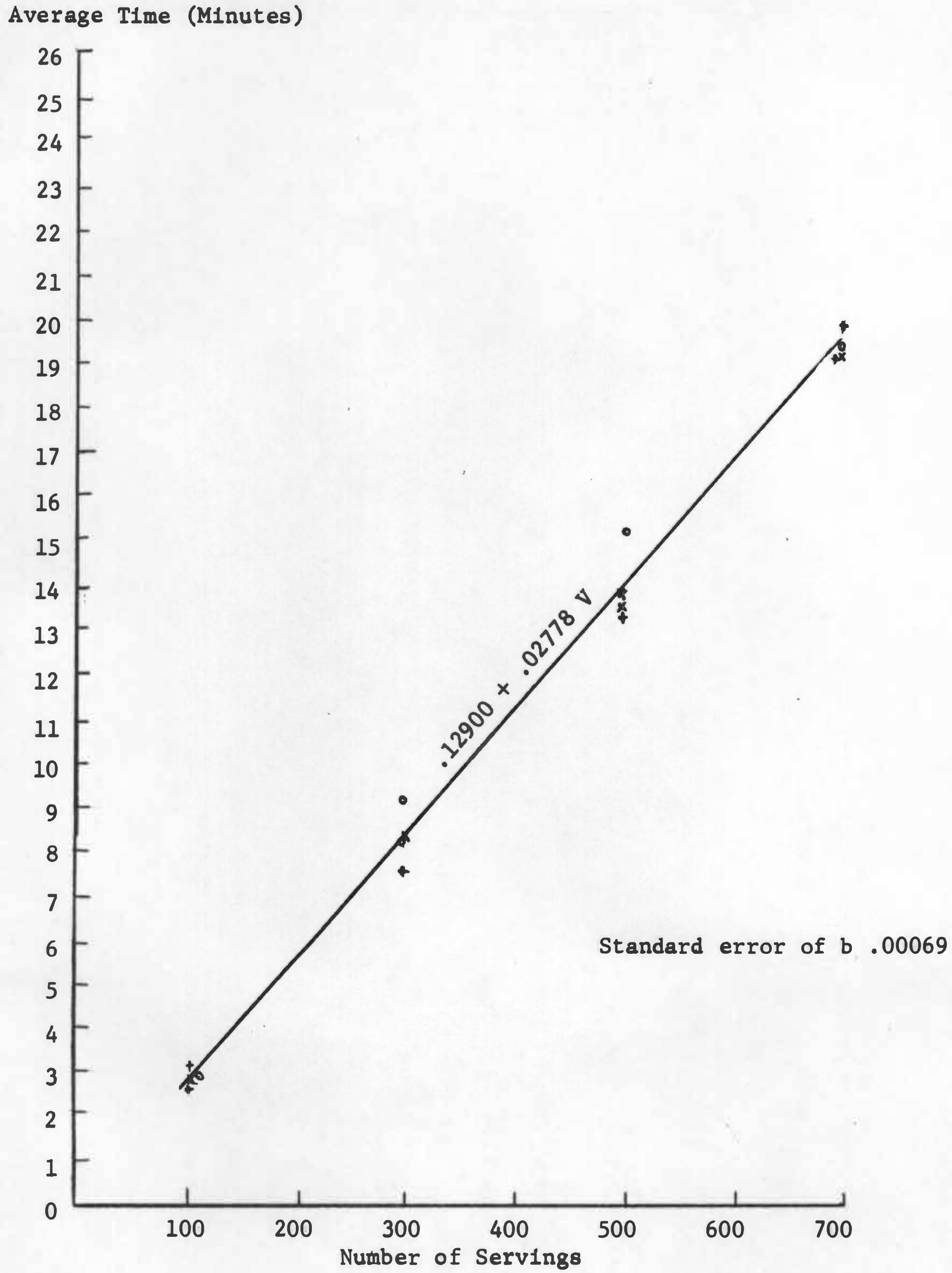


Figure 6. Processing time data for panning pork chops on counter pans (20 x 12 x 2-1/2 inches).

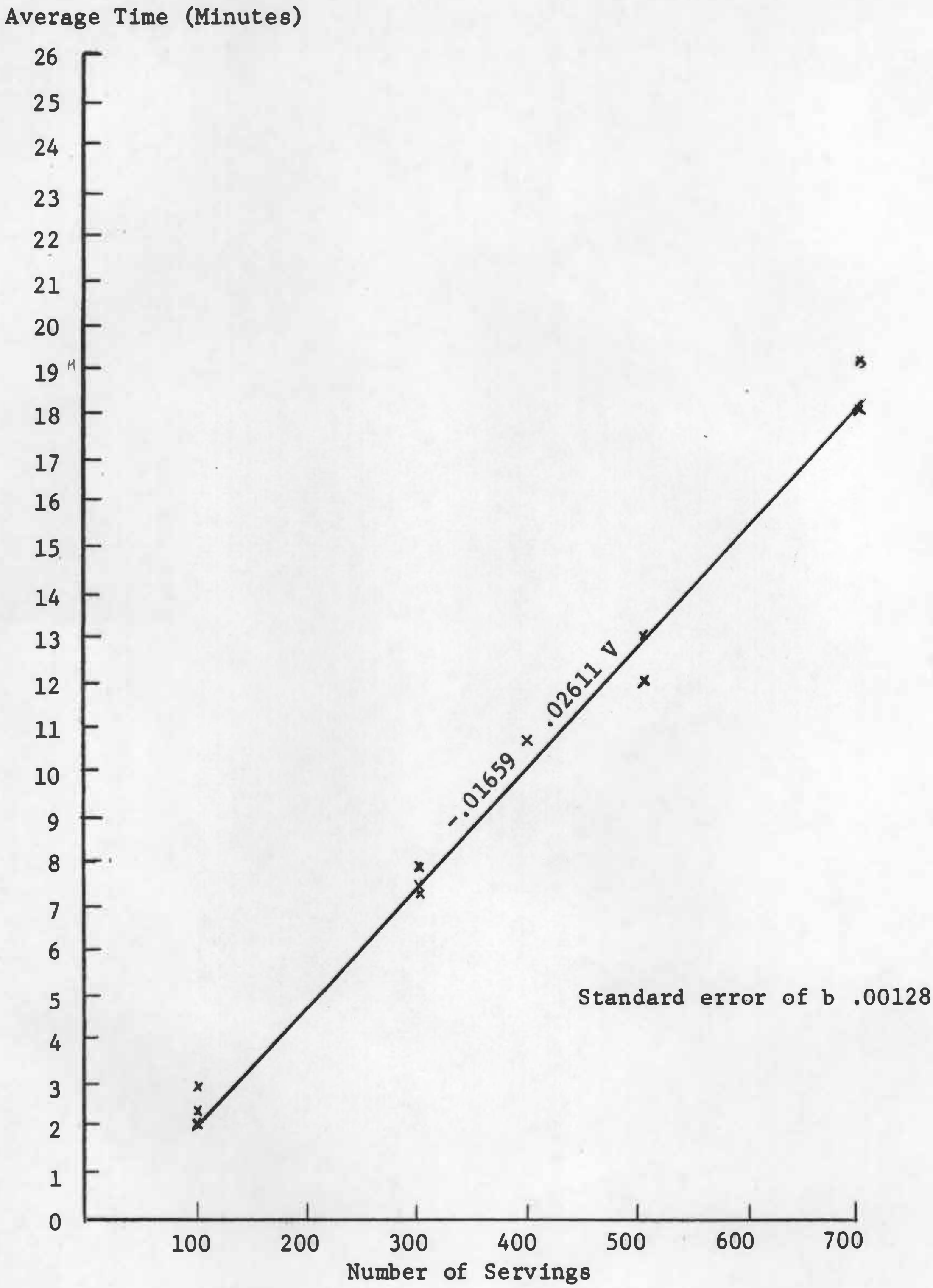


Figure 7. Processing time data for Cook A, panning pork chops on bun pans (26 x 18 x 3/4 inches).

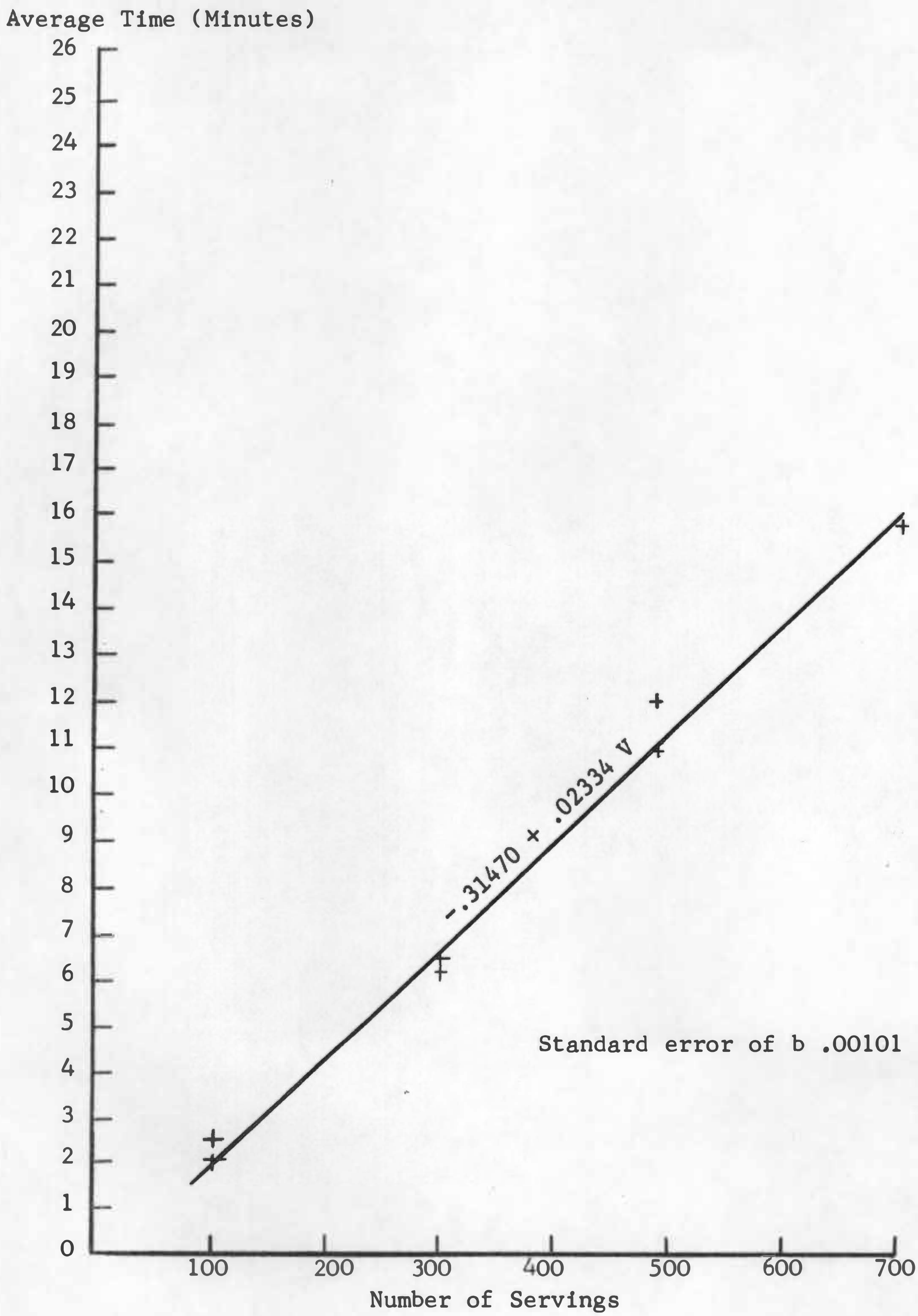


Figure 8. Processing time data for Cook B, panning pork chops on bun pans (26 x 18 x 3/4 inches).

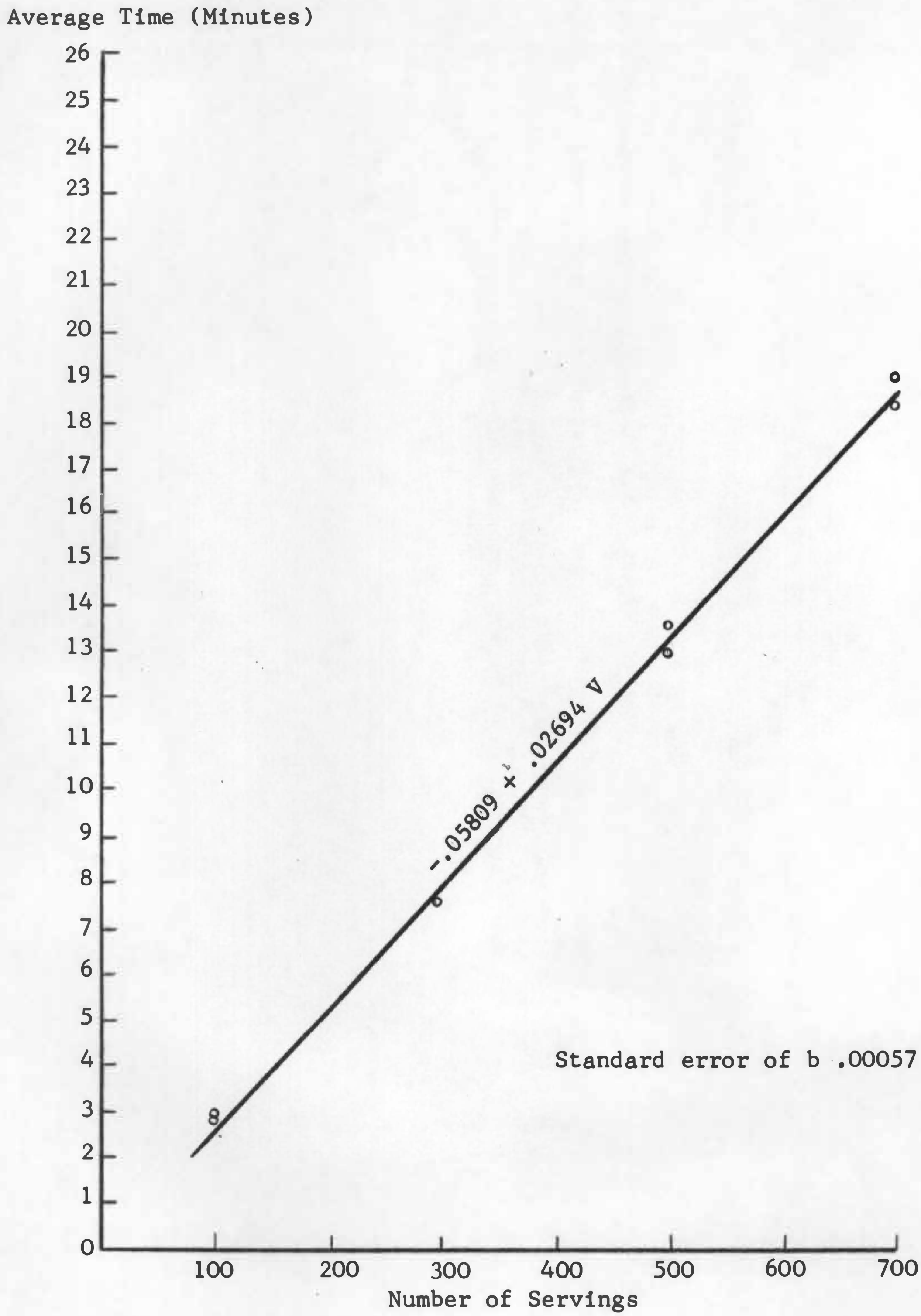


Figure 9. Processing time data for Cook C, panning pork chops on bun pans (26 x 18 x 3/4 inches).

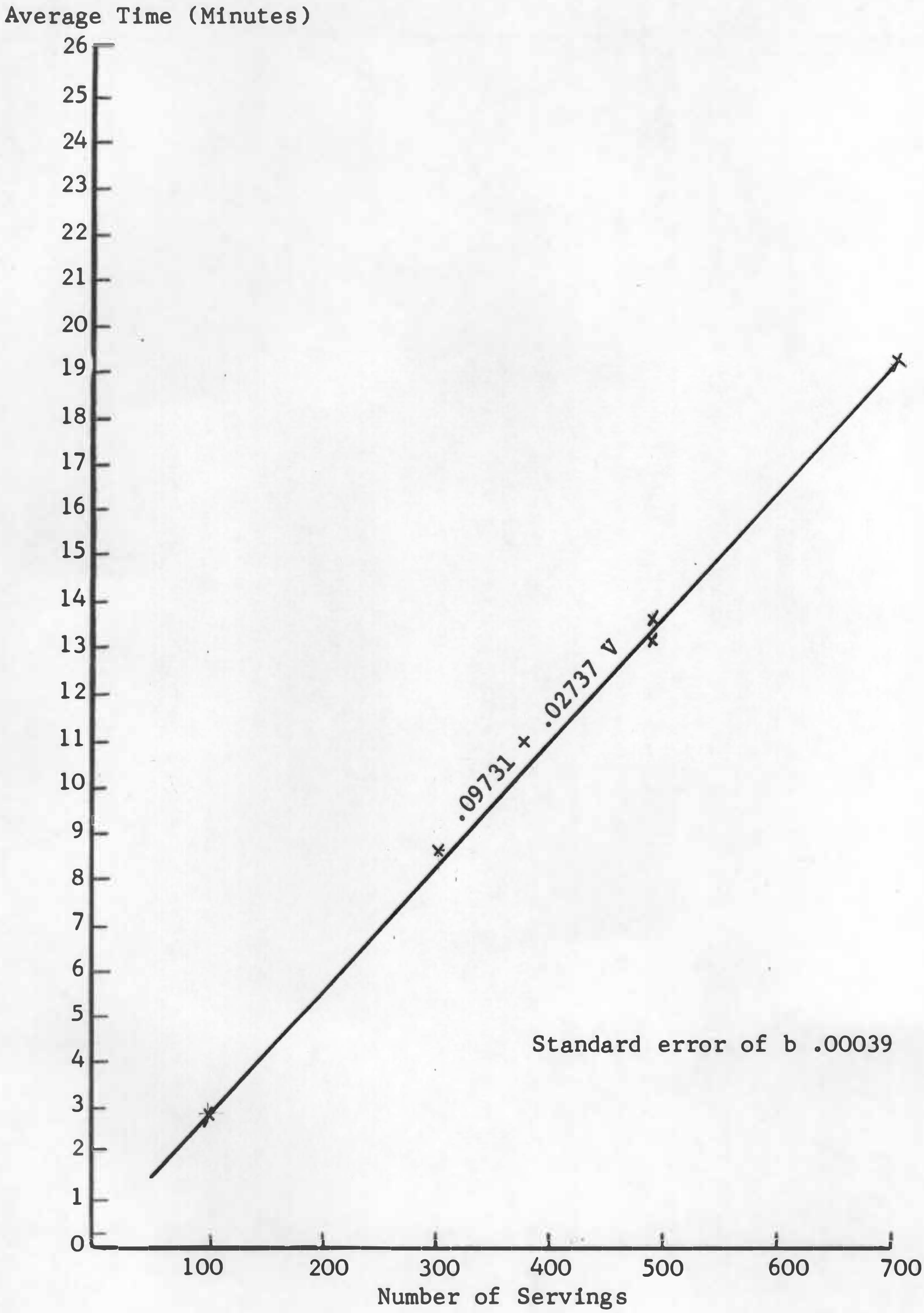


Figure 10. Processing time data for Cook A, panning pork chops on counter pans (20 x 12 x 2-1/2 inches).

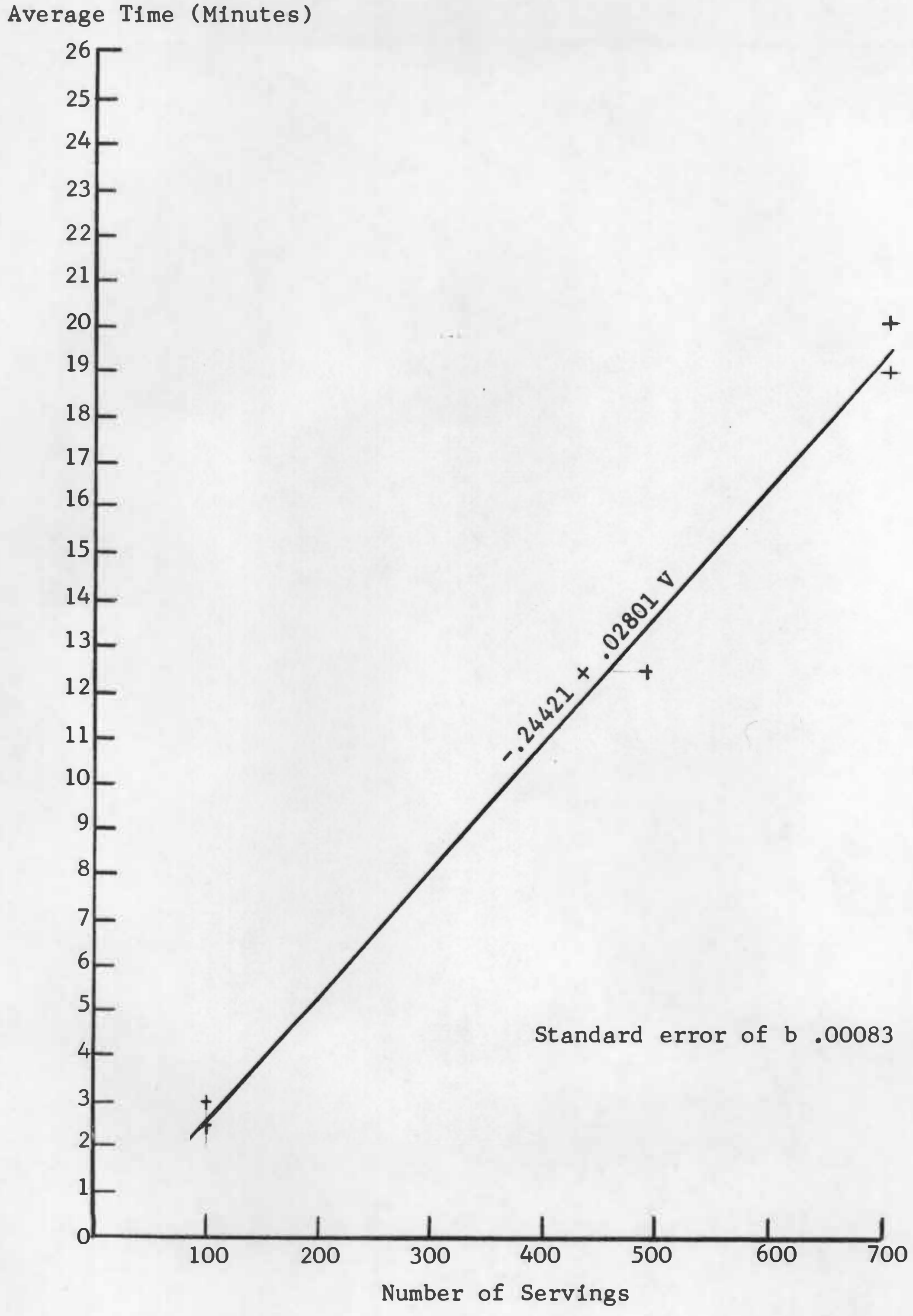


Figure 11. Processing time data for Cook B, panning pork chops on counter pans (20 x 12 x 2-1/2 inches).

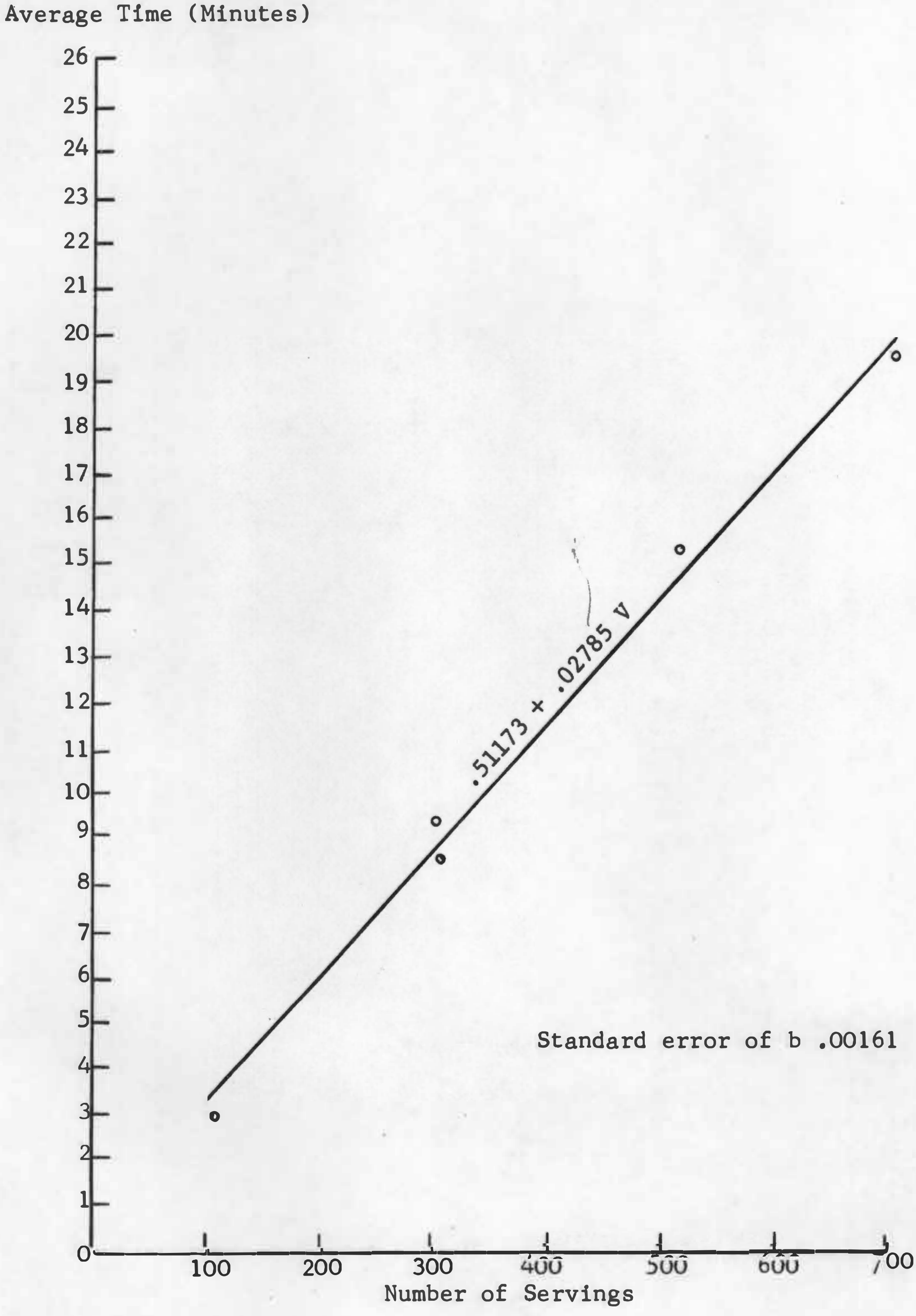


Figure 12. Processing time data for Cook C, panning pork chops on counter pans (20 x 12 x 2-1/2 inches).

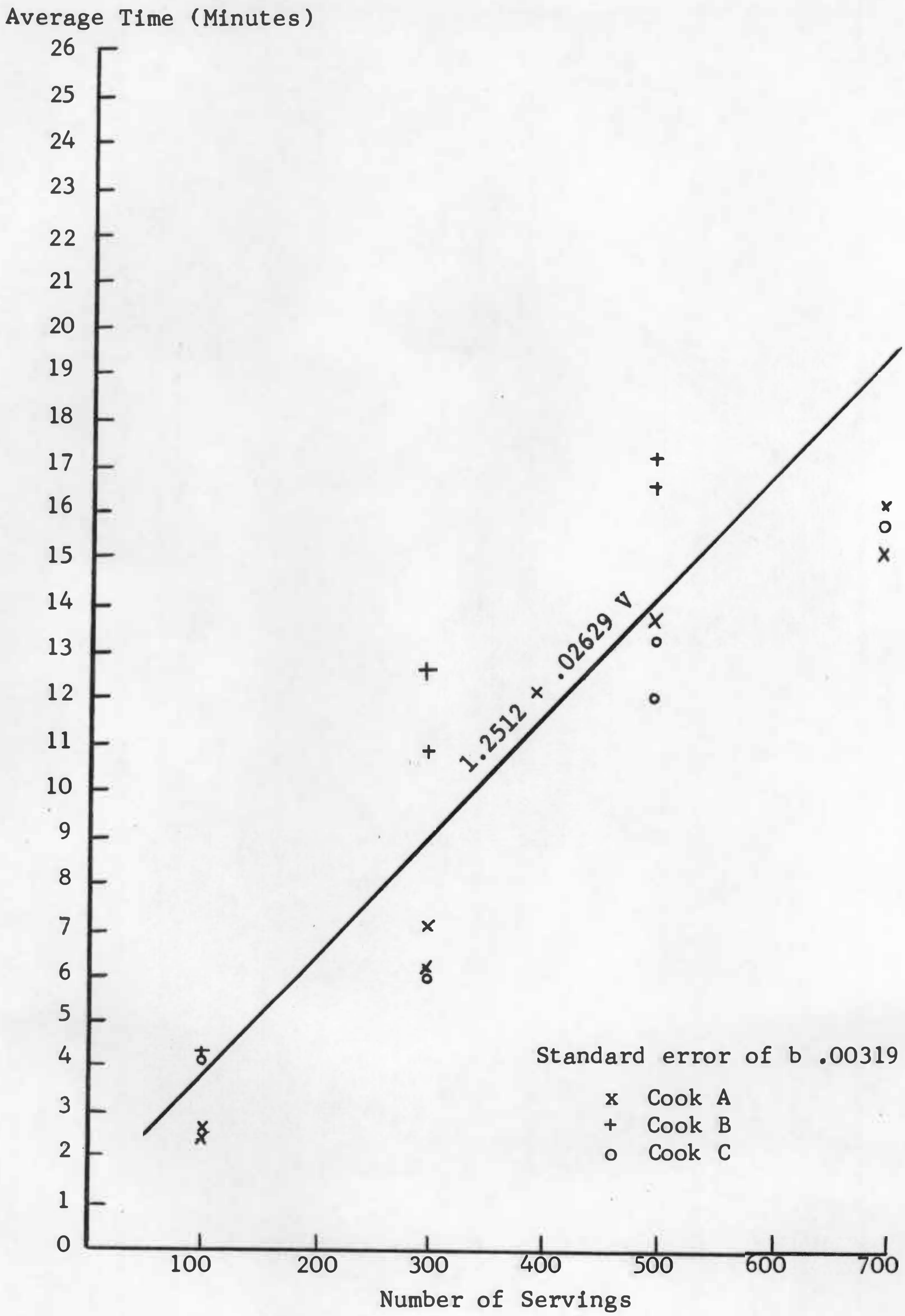


Figure 13. Processing time data for panning and dredging meat cubes on bun pans (26 x 18 x 3/4 inches).

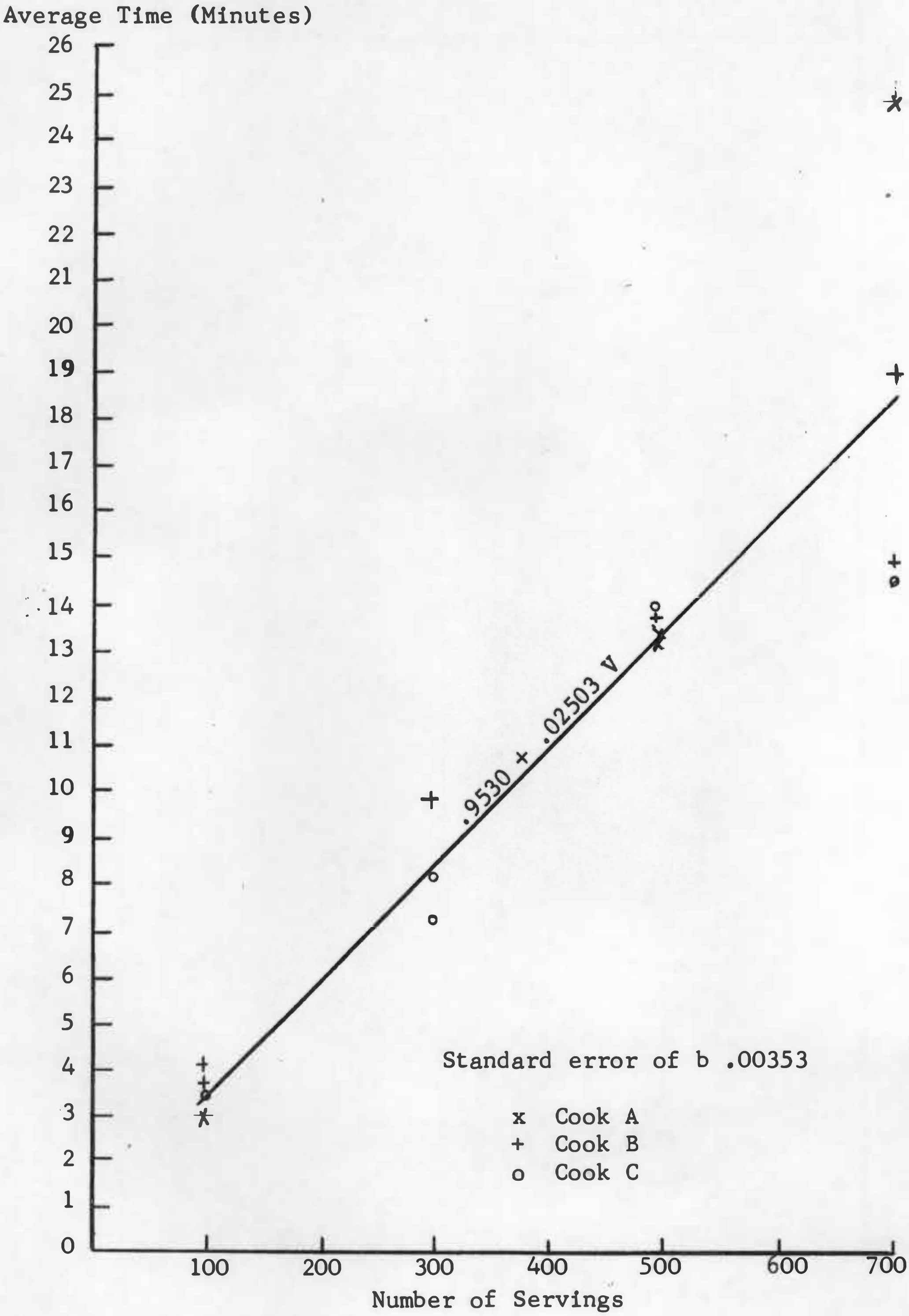


Figure 14. Processing time data for panning and dredging meat cubes on counter pans (20 x 12 x 2-1/2 inches).

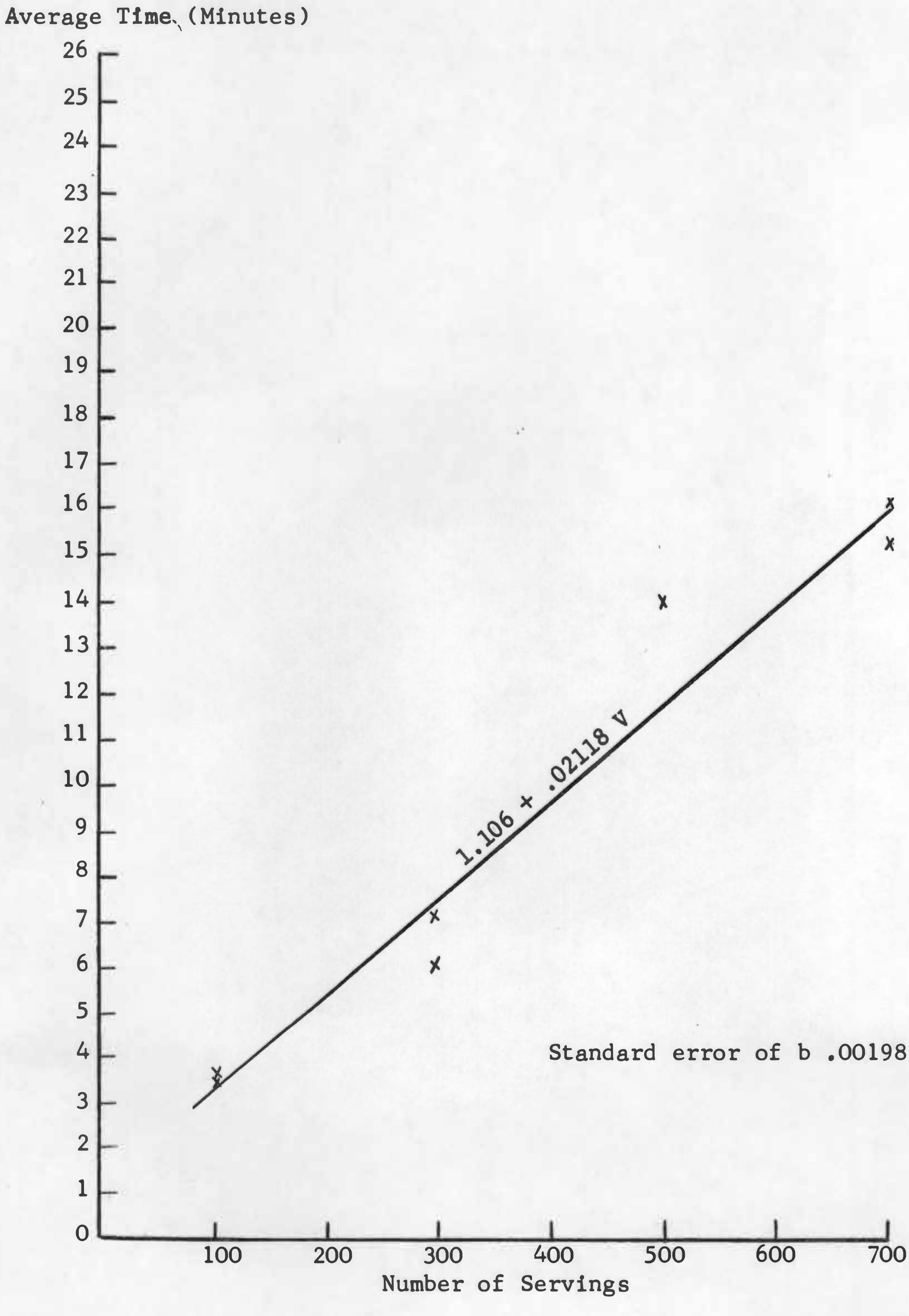


Figure 15. Processing time data for Cook A, panning and dredging meat cubes on bun pans (26 x 18 x 3/4 inches).

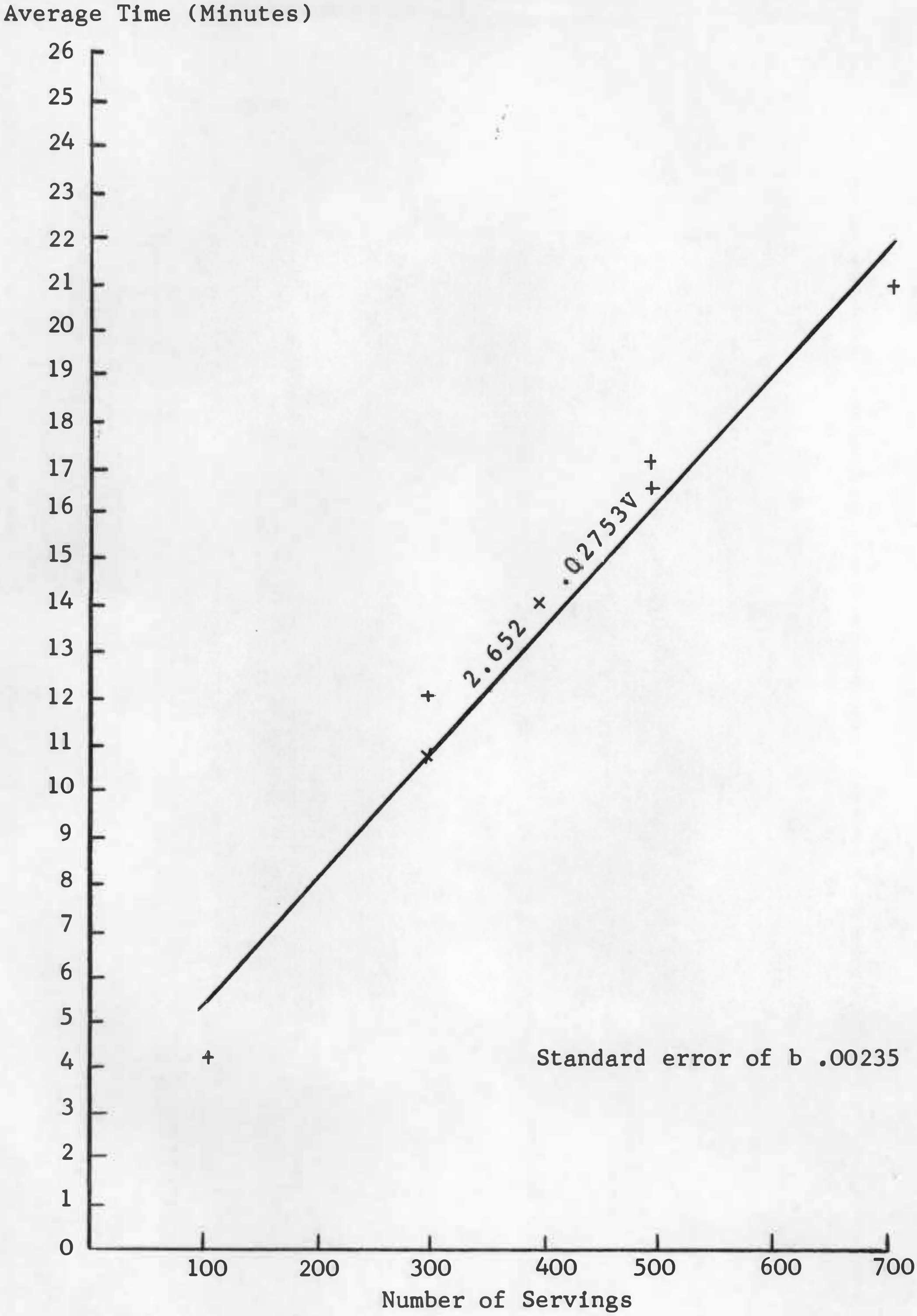


Figure 16. Processing time data for Cook B, panning and dredging meat cubes on bun pans (26 x 18 x 3/4 inches).

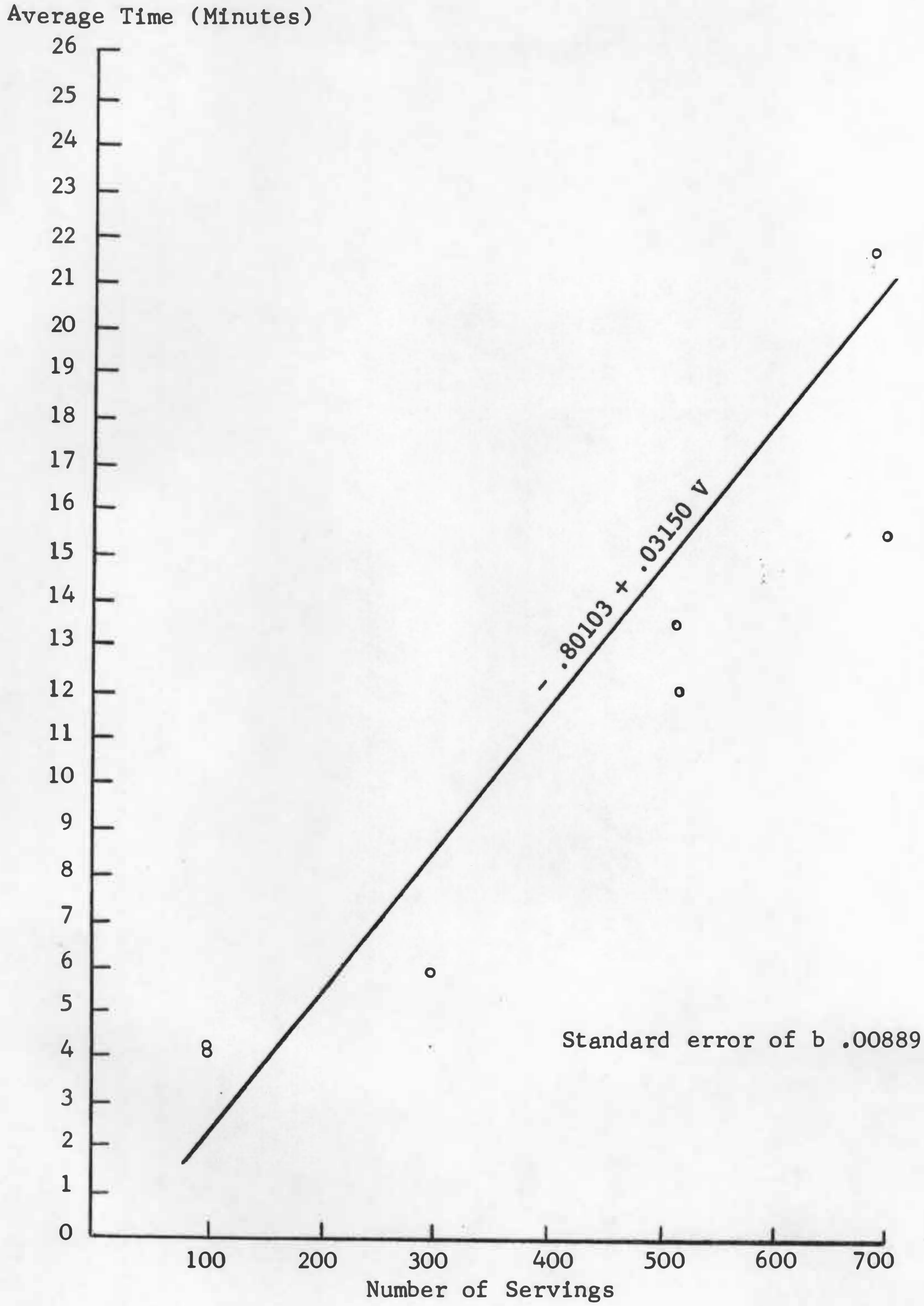


Figure 17. Processing time data for Cook C, panning and dredging meat cubes on bun pans (26 x 18 x 3/4 inches).

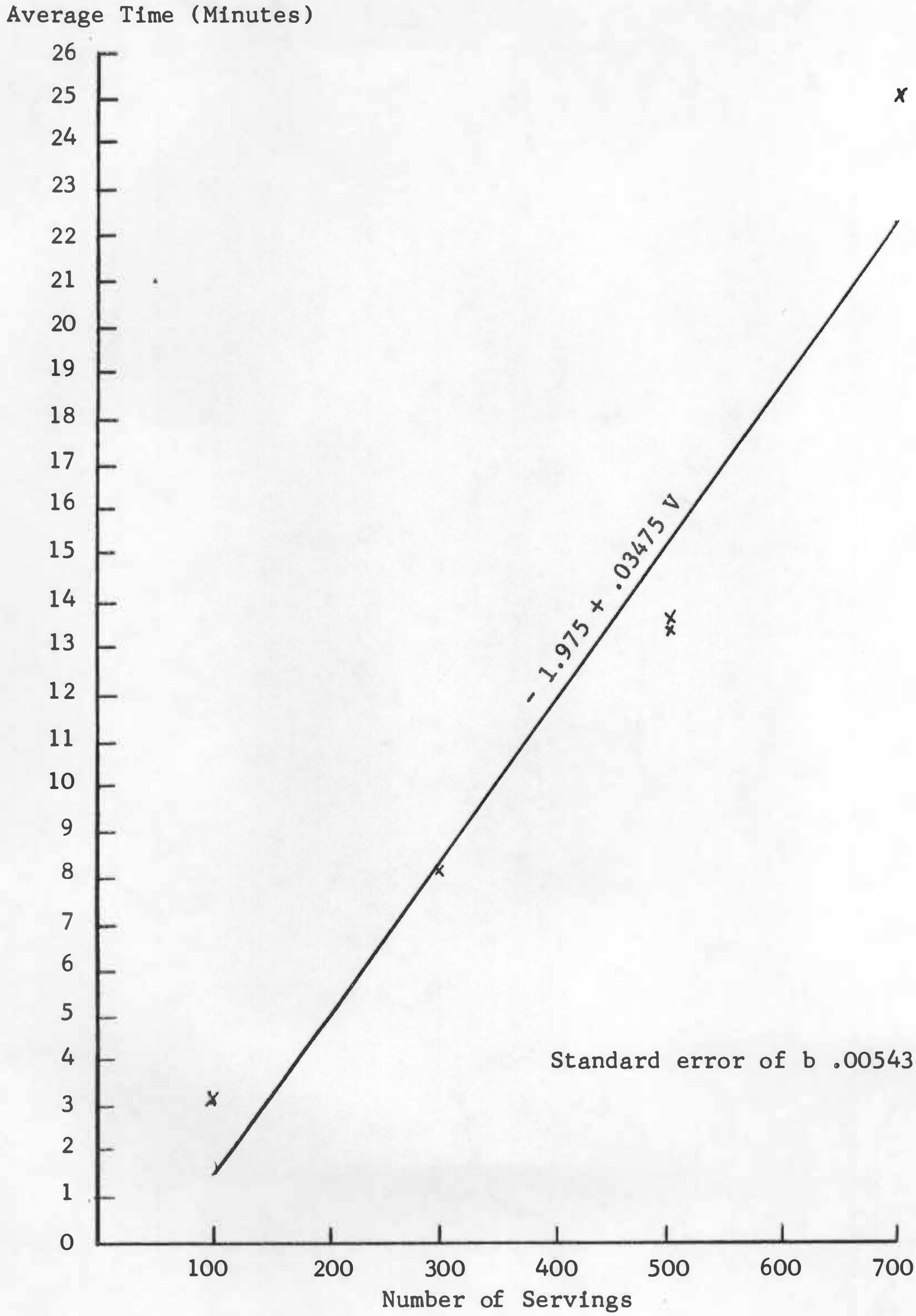


Figure 18. Processing time data for Cook A, panning and dredging meat cubes on counter pans (20 x 12 x 2-1/2 inches).

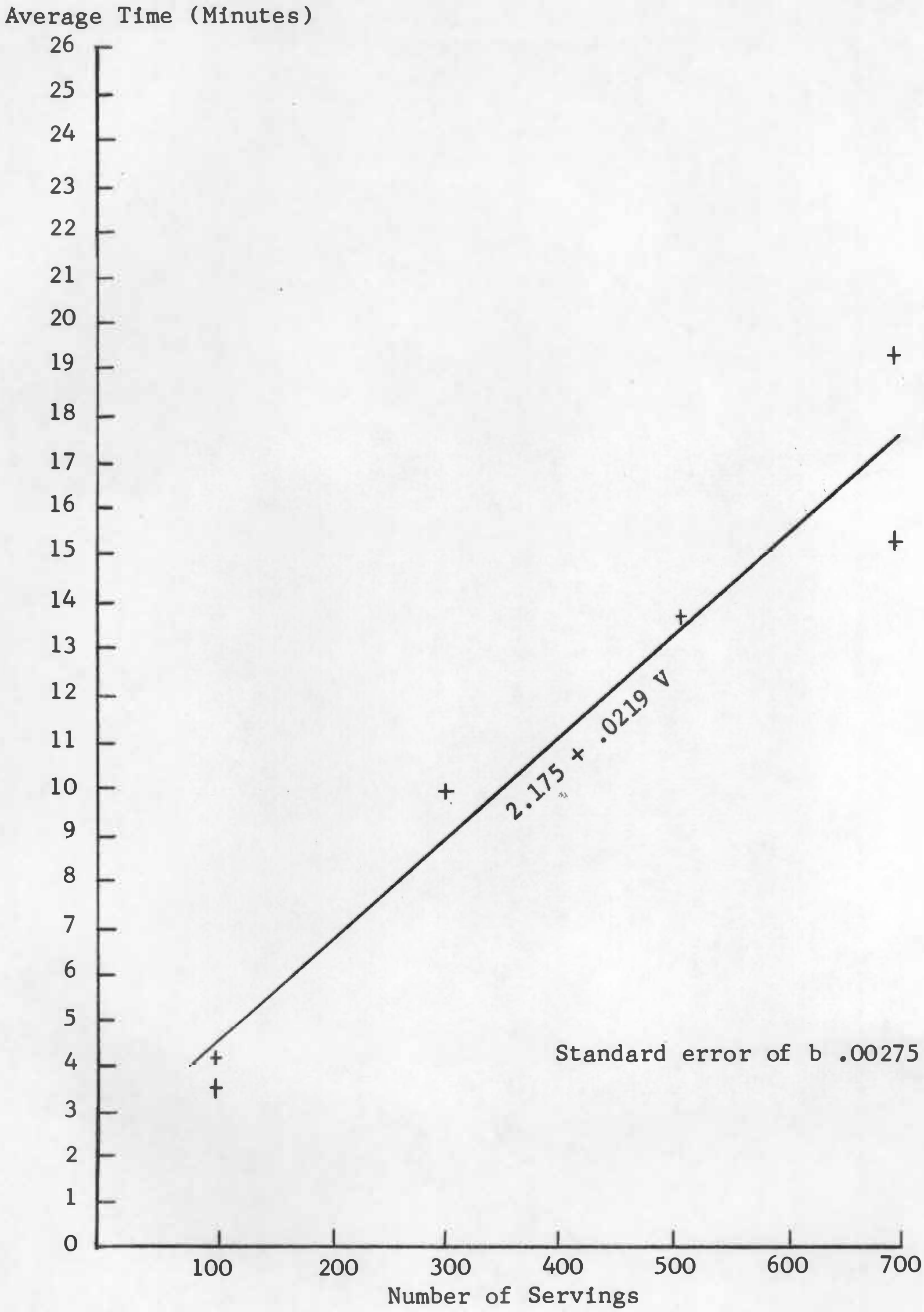


Figure 19. Processing time data for Cook B, panning and dredging meat cubes on counter pans (20 x 12 x 2-1/2 inches).

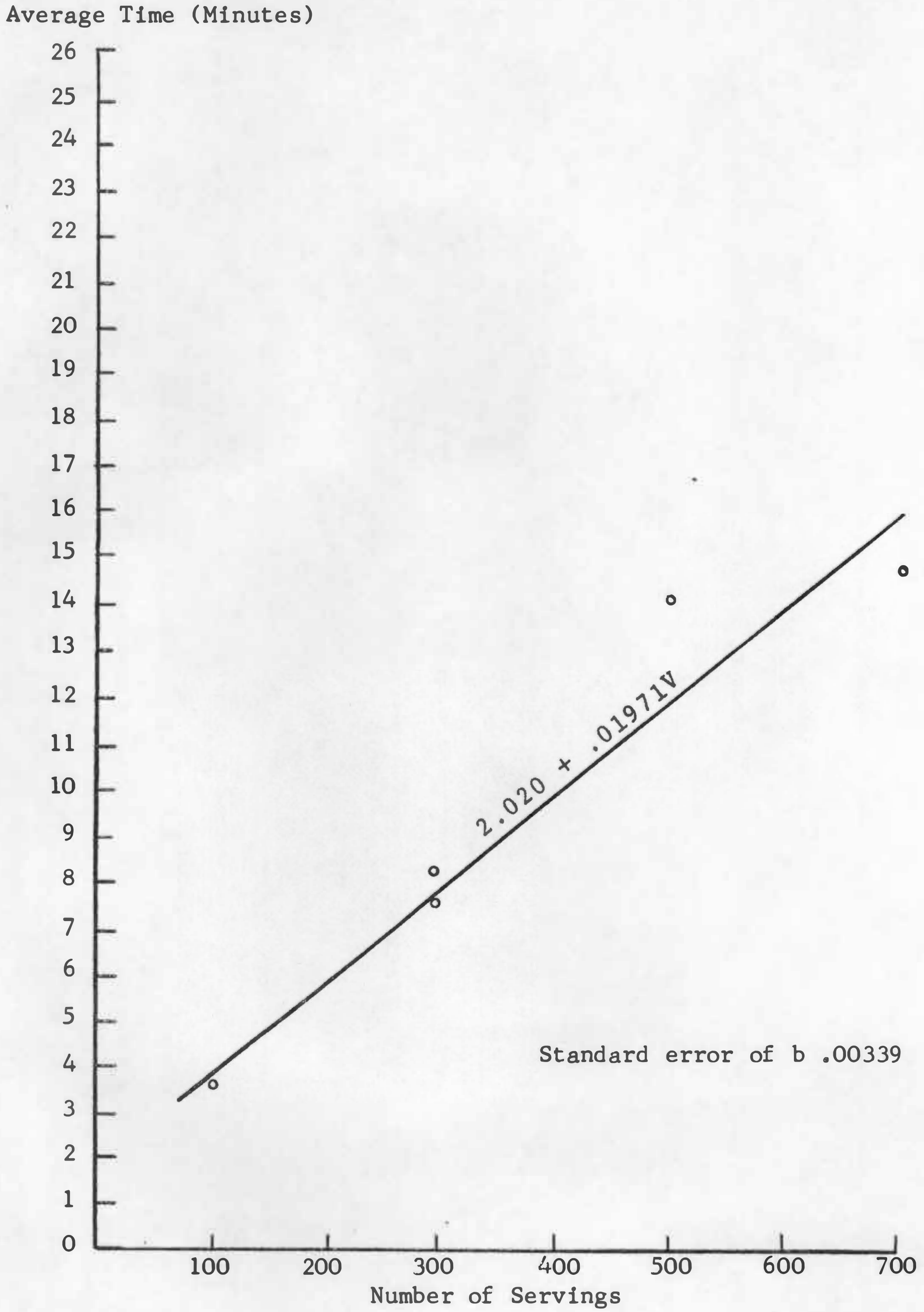


Figure 20. Processing time data for Cook C, panning and dredging meat cubes on counter pans (20 x 12 x 2-1/2 inches).

VITA

Vivian Sue Connelly was born in Northumberland County, Virginia, on June 9, 1936. She received a Bachelor of Science degree in Institution Management from Madison College, Harrisonburg, Virginia, in June, 1958. She was commissioned a Second Lieutenant in the Army Medical Specialist Corps in 1958 and completed an Army Dietetic Internship at Brooke General Hospital in 1959.

Major Connelly has been assigned various therapeutic and administrative staff positions in the Food Service Divisions at Brooke General Hospital and Walter Reed General Hospital. She was awarded the Army Commendation Medal with Oak Leaf Cluster for meritorious service during her two assignments at Walter Reed General Hospital.

In 1964 she was assigned as Chief, Food Service Division, Rodriquez US Army Hospital, Fort Brooke, Puerto Rico.

Major Connelly was serving as Chief, Food Service Division at US Darnall Army Hospital, Fort Hood, Texas, in September, 1970, when she was selected to enter The University of Tennessee, Knoxville, to work for a Master of Science degree in Institution Administration.