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A Study of Benefits Gained from Industrial Mathematics by Students in the Inglewood Unified School District, Inglewood, California

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A STUDY OF BENEFITS GAINED FROM INDUSTRIAL MATHEMATICS BY STUDENTS IN THE INGLEWOOD UNIFIED SCHOOL DISTRICT, INGLEWOOD, CALIFORNIA

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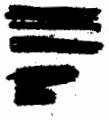

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CHAPTER I

THE PROBLEM AND ITS VALUE AND DEFINITIONS OF TERMS USED

Because the value of teaching Industrial Mathematics in relation to the expense and number of students who benefit has been questioned, this study should be of particular importance to the Inglewood Unified School District, Inglewood, California. And since the problem of high school electives and their relative value faces every school district, particularly in these times of "tightened" schedules and increased requirements, this study should also be of value to any school districts trying to determine whether or not they can afford to keep Industrial Mathematics, or a mathematics course of similar content, in the curriculum. The study should also be of value to schools considering the addition of a similar course to meet increasing demands.

I. THE PROBLEM

The purpose of this study was, first, to make a comprehensive comparative study of the records of students who have completed the course in Industrial Mathematics offered in the Inglewood School District with those who have not. The study took like samplings of students with comparable backgrounds and I.Q.'s. It included a check of

grades before, during, and after completion of the course. It attempted to show the statistical gain or lack of gain resulting from completion of the course.

Second, in order to show the value to students who completed the course in Industrial Mathematics and then made direct use of it in their jobs, the study attempted a follow-up of those who have taken Industrial Mathematics and are actually benefiting on the job. Students currently enrolled in Industrial Mathematics were also questioned regarding their opinions of the value of the course. Altogether, questionnaires were sent to a total of 153 students in the Inglewood Unified School District. Replies were received from 126 students, making an 82.3 per cent return.

Third, in addition to the statistical approach and interviews with the students, the instructors in industrial arts and other related areas were interviewed to determine whether they feel the Industrial Mathematics course improved the work of students in related fields. There were 39 teachers who replied out of a total of 42 teachers contacted for a 92.8 per cent reply. Teachers of Industrial Mathematics were questioned separately regarding their views. Four teachers were contacted and all replied. Questionnaires were sent to local industries to get an idea of their evaluation of Industrial Mathematics. Fifty employers of high school graduates were contacted. Thirty-four questionnaires were answered for a 68 per cent return. In addition to replies

to specific questions many suggestions for improving Industrial Mathematics were offered. Some of these are shown on page 74 in the Appendix of this paper. On pages 71, 72, and 73 of the Appendix there is also a list of the specific employers contacted.

Fourth, library research was used to obtain the views of various recognized educators on the value of such a course as Industrial Mathematics.

II. DEFINITIONS OF TERMS USED

Little technical terminology is used in this paper. It is well to make clear here, however, that the titles Industrial Mathematics, Shop Mathematics, and Technical Mathematics are very similar and can be interchanged. Later the paper discusses in detail the material taught in this particular course so that it can be compared with similar courses taught in other districts. It might also be well to mention here that "practical" mathematics, "remedial" mathematics, and "business" mathematics - - entirely different courses - - are not considered in this study.

A brief definition of Industrial Mathematics as considered in this paper is as follows: Industrial Mathematics is involved with the practical application of mathematics to the common everyday problems of our industrial culture. The course includes solving of problems relating fractions, decimals, money, percentage, linear measure, board measure,

square measure, cubic measure, and a detailed study of solving typical shop formulas.

Other specialized terms used in this paper have been explained as they were used. The object has been to keep this paper as uncomplicated as possible to enable it to be used as a simple reference with a minimum of additional research.

CHAPTER II

AN EXPLANATION OF MATERIAL COVERED IN INDUSTRIAL MATHEMATICS IN THE INGLEWOOD UNIFIED SCHOOL SYSTEM

In order to evaluate Industrial Mathematics as taught in the Inglewood Unified School District, it was necessary to show as complete a picture as possible of the material covered in the course. To do this, the study examined a complete outline as presented in the Inglewood district's teaching guide, the text used in the past and currently being used, and the condensed summary of the course content as listed in the counselor's office.

The Inglewood Unified School District Teaching Guide presented quite a complete listing of the materials covered in Industrial Mathematics. The following outline is taken from this guide.

Chapter III. THE TEACHING OF SHOP (INDUSTRIAL MATHEMATICS)

I. The Place of Shop Mathematics in the Curriculum

Shop Mathematics is a course designed to meet the mathematical needs of students majoring in industrial arts or allied fields. Most students take this course in the 9th or 10th grades. For students of demonstrated ability a second year of advanced shop mathematics is offered. The over-all objectives of the course are to give each student the skills and knowledge needed to work the everyday mathematical problems of home and business, and to give him a detailed understanding of the type of mathematical problems he will encounter in industrial or trade work.

II. Expected Outcomes

The following learning outcomes comprise the goals for the course in Shop Mathematics. The student:

1. Has the opportunity to develop competency in using integers, fractions, decimals, and denominate numbers.

2. Increases his understanding and facility in solving the mathematical problems of daily life.

3. Has a knowledge and understanding of the problems likely to be encountered in carpentry, cabinetmaking, lathing, plastering, paperhanging, sheetmetal work, brick and masonry work, concrete work, printing, machining, toolmaking, automobile works, and general factory work.

4. Increases his understanding of the use of various units of length, area, volume, and weight.

5. Is better prepared for work in one of the trades or in industry.

III. Suggested Teaching and Learning Experiences

The following suggested activities are illustrative of the means which teachers and students have found useful for achieving the goals of the course.

1. Students estimate, without any writing, the answers to a set of problems; then they work out the exact answers to see how close their estimates were.

2. Students talk with carpenters, machinists, painters, contractors, draftsmen, to find out how they use mathematics.

3. Students learn how to use a slide rule in multiplication, division, and proportion.

4. Obtain paycheck stubs showing hours worked at overtime and regular time, hourly rate, deductions, etc., and have students calculate the take-home pay.

5. Student or students make an oral report to the class on Workman's Compensation Insurance.

6. Ask students to assume they are contractors bidding on the construction of a garage for a home or a roofed barbecue area and to submit a written estimate of the cost giving a breakdown of the costs of different operations and materials, with a list of specifications for the materials.

7. Using the classified advertisement section of the daily papers, especially the Sunday editions, have the students make a list of the different jobs in the trades which are most in demand with their rates of pay.

8. The class together makes a list of all the sources where as adults they could borrow money. Then at a later date after reading, talking to people and other investigating, have the class discuss the advantages and disadvantages of these sources.

In considering learning activities in Shop Mathematics it should be noted that many of the activities in the shop courses contribute to a student's knowledge of mathematics. The shop courses might well be thought of as the laboratory part of Shop Mathematics.

IV. Organization and use of Subject-Matter Content

It is important that the subject matter content of this course be organized and utilized in ways that are as effective as possible for achieving the desired learning outcomes. Units may be developed for the following areas:

A. First year

1. Fractions - fundamental operations and practical applications.

2. Decimal fraction - fundamental operations and practical applications.

3. Money - wages, purchases, costs, estimates.

4. Percentage - discounts, profits, trade discounts, losses, averages, efficiencies, ratings.

5. Linear measure - lengths, distances, amounts, quantities, estimates.

6. Board measure - board feet, shop practice, estimates, practical jobs.

7. Square measure - surfaces, areas, weights, estimates, trade calculations.

8. Cubic measure - volumes, weights, capacities, estimates, industrial calculations, trade applications.

9. Shop formulas - cutting speeds, R.P.M., belting, screw threads, tap drills, bolts and screws, gears and sprocket drives, tapers, taper turning.

B. Second year

The second year of Shop Mathematics covers essentially the same topics as the first year, but the treatment is more detailed and the problems more complex.

V. Instructional Materials

A. Textbook

1. First Year - Applied Mathematics, 1939 Johnson, James A.

2. Second Year - Mathematics for Technical and Vocational Schools - 1946 Slade and Margollis

B. Audio-Visual

Films suitable for Shop Mathematics are listed both under mathematics and industrial education in Films for Secondary Schools and Colleges, County Superintendent.

C. Materials for the Teacher

These will be similar to materials for any

> mathematics teacher, consisting of periodicals, books, and visual aids that allow the students to see what is being done (1:9-12).

It might be mentioned here that due to increased numbers of required courses in the general curriculum for high school students in the Inglewood district, the second year of Industrial Mathematics was offered only one year at Inglewood High School, then dropped. At Morningside High School, Industrial Mathematics was taught on an every-other-year basis for similar reasons. There was also a shortage of personnel to teach the course. The beginning course in Industrial Mathematics was resumed on a yearly basis at Morningside in 1959. An even greater increase in the required curriculum for the students and the consequent drop in enrollment for this class has again threatened to eliminate it. At the present time, (fall semester, 1960) 28 students are enrolled in Industrial Mathematics at Morningside High out of a total school enrollment of 1,875 (2:1). The enrollment in the course at Inglewood High is 45 out of a total enrollment of 1,860 (3:1). Obviously, a rather small percentage of students are benefiting from Industrial Mathematics, making a study of the value of the course even more pertinent.

Since the second year of Industrial Mathematics has not been reinstated at either high school, this paper has included a general outline of only the first-year text, Applied Mathematics, by James A. Johnson (4).

The instructional material and the 1,100 and more problems in this text meet full requirements for elementary mathematics in the building-trades branches, including carpentry, cabinetmaking, lathing, plastering, painting, paperhanging, sheet-metal work, brick, mason, and concrete work. The book also presents typical problems in the printing trades, the machinist and toolmaking trades, the auto-mechanics trades, and general factory type work. The draftsmen and the technicians of industry will also find it helpful. The text is divided into the following units of instruction, followed by answers that relate to the problems in each unit:

1. Fractions: Fractions are reviewed thoroughly to allow the student to become adept in their use. Fractions are a common problem area for students and adults. For this reason they are covered quite thoroughly even though the subject matter may be repetitious. In Applied Mathematics, (4:1-66) they have been broken down as follows:

A. Definitions pertaining to fractions

1. Proper fractions
2. Improper fractions
3. Mixed numbers

B. Changing fractions to equivalent fractions

C. Addition of fractions

1. Addition of proper fractions
2. Addition of mixed numbers

D. Subtraction of fractions

1. Subtraction of fractions having common denominators

2. Subtracting fractions not having common denominators
3. Subtracting a fraction from a mixed number
4. Subtraction of mixed numbers

E. Multiplication of fractions

1. Multiplying a proper fraction by a proper fraction
2. Multiplication of mixed numbers
3. Multiplying mixed numbers or fractions by whole numbers
4. Cancellation of fractions

F. Division of fractions

1. Division of a proper fraction by a proper fraction
2. Division involving mixed numbers

Special attention has been given to decimal fractions. The complete understanding of this area is important for every-day use as well as in direct use in industrial occupations. Here is an outline of decimal fractions as covered in the text, Applied Mathematics, by James A. Johnson (4:67-108):

A. Interpretation of decimal fractions

B. Addition of decimals

C. Subtraction of decimals

D. Multiplication of decimals

E. Division of decimals

F. Changing fractions to decimals

G. Changing decimals to fractions

The text devotes a brief area to the explanation of money as it is used in everyday living. The object is to help the student understand how his share of income is

arrived at, how it will be spent, and how to manage his money instead of letting his money manage him (4:109-120).

A. Wages

B. Purchases

C. Costs

D. Estimates

Industry requires a good understanding of percentages. Many employers feel that even the unskilled line-worker needs a basic understanding of percentage in order to understand his wages in relation to output. In other words, each worker needs to understand the ratio between output, profit percentage, and his own wages. Therefore, the text includes the following (4:121-142):

A. Changing per cent to fractional form

B. Changing fractions to per cent form

C. Discounts

D. How to determine per cent

E. Determining efficiencies, profits, and ratings

For anyone interested in industrial arts or related fields, linear measure, board measure, square measure, and cubic measure are important. Applied Mathematics covers the areas as follows (4:143-308):

A. Linear measure

Lengths (changing from one denomination to another, adding units of different denominations, subtracting units of different denominations, multiplying units of two or more denominations, division of units of measure)

B. Board measure

1. Definition of lumber terms
2. Calculation of board feet

C. Square measure

1. Definition of the square
2. Definition of the rectangle
3. Definition of the parallelogram
4. Definition of the trapezoid
5. Definition of the various angles
6. Definition of the various triangles
7. Definition of a circle
8. Explanation of the formula for computing the area of each form
9. Definition of an ellipse
10. Areas of irregular flat surfaces
11. Common units of square measure
12. Changing from one denominator to another
13. Surface areas of solids (squares, rectangular solids, cylinders).

In order to relate the information presented in the text to practical situations familiar to the students, Johnson, in Applied Mathematics, includes problems in specific job areas (4:231-263).

A. Application of square measure and surface measure to trades

1. Lathing
2. Plastering
3. Brickwork
4. Shingling
5. Painting
6. Paperhanging
7. Printing
8. Paper measure

The study of measures is continued in Applied Mathematics with cubic measure (4:143-308):

A. How cubic measure is determined

B. Volumes of regular solids

1. Cubes
2. Rectangular prism
3. Cylinders, or solids resembling cylinders
4. Spheres, or solids having spherical forms
5. Calculating volumes of irregular forms

C. Liquid measure

1. Changing units of one denomination to units of another denomination
2. Problems relating to liquid measure

D. Dry measure

Applied Mathematics also includes problems in the field of common shop theory and specific jobs. The following shows these specific areas (4:311-418):

A. Surface speeds

B. Cutting speeds

C. Pulleys connected by belts

1. Definitions of terms and effects
2. Computing problems

D. Belting

1. Open style
2. Close style or crossed style
3. Length of belting in a coil

E. Screw threads

1. Definitions of terms and their effect on problem solving
2. Problems involving threads

F. Tap-drill calculations

G. Gear drives and gear drives calculations

1. Simple gear trains
2. Compound gear trains

H. Sprocket and chain drives

I. Taper turning.

The several hundred illustrations, sketches, and drawings throughout the text are so arranged that the student may receive a step-by-step training in the interpretation and understanding of shop sketches and working drawings.

The outline of the book, together with the teaching guide for Industrial Mathematics, gives an accurate picture of the subject as taught in the Inglewood district. There have been some variations, of course, depending on the abilities present in individual classes and upon the individual teachers presenting the material. For the purposes of this paper, however, the subject may be considered to consist of the material as listed here.

CHAPTER III

THE VALUE OF INDUSTRIAL MATHEMATICS IN RELATED SUBJECTS

One of the prime considerations in evaluating a given subject in the school curriculum is its value in relation to other subjects. If the learning from one class will carry over to another, its value is naturally greater. This is especially true in the eyes of the student himself, who is most concerned with what the subject he is planning to take will do for him now.

Industrial Mathematics has been designed in part to aid students in their work in other classes. This chapter has been included in the hope that it will show definitely whether or not Industrial Mathematics has accomplished this purpose.

I. THE AIMS

As already stated, one of the aims of Industrial Mathematics is to help the students in other areas they will encounter in their education. For example, Lucien Kinney and Richard Purdy, in Teaching Mathematics in the Secondary School, mention the need to tie mathematics and science together:

> In the development of all technical fields, of course, mathematics is basic. The engineer uses a wide range of mathematical data and methods

> and combines them with empirical data and methods; thus science and mathematics combine in helping the engineer to visualize and analyze his problems (5:3).

One of the basic problems facing any educational institution is its "holding power," that is, the ability to hold the interest of the students and therefore keep them enrolled. This is particularly true at the high school level, where so many students decide they are old enough to be independent and begin to feel the need to be financially independent as well. In the past, and perhaps even more in the present when there seem to be so many more jobs available to youth, there is a great temptation to quit school upon reaching the legal "drop out" age. For this reason, too, the school needs to gear its curriculum to provide a kind of practical education the student can see will benefit him. This need is explained in Principles of Public Secondary Education:

> To improve the holding power of the high school, then, it is necessary to demonstrate to many pupils that there is a worthwhile relationship between what is being taught and the activities of daily living in the community (6:111).

In other words, the student is more likely to see the value of completing his education if he can see how the subjects he is taking are related to situations or problems he is encountering daily. The value of a practical course such as Industrial Mathematics in this respect is discussed by William Micheels and Wesley Sommers in The Minnesota Plan

For Industrial Arts Teacher Education:

> There will be a growing need for secondary school learning experiences which might be termed, for want of a better name, "vocational-technical orientation: or "applied technology." Such experiences might be under the joint direction of the science, mathematics, and industrial education teachers (7:24).

Industrial Mathematics, as already outlined in Chapter Two of this paper, has been designed to meet this need to correlate mathematical learning with other courses taught within the school and with related subjects encountered outside the classroom. According to the evaluation of other educators, then, theoretically, Industrial Mathematics should be of benefit and should be even more important in the present curriculum than in the past.

II. EVALUATION BY TEACHERS

The field most closely related to Industrial Mathematics, of course, would be industrial arts. According to the opinion of industrial arts teachers in the Inglewood Unified School District, Industrial Mathematics is definitely beneficial to students who enroll in their classes. Sixty-six and two thirds per cent of all the industrial arts teachers in the district felt Industrial Mathematics would benefit 95 per cent of the students enrolling in their classes (Figure 1).

The next most closely related field to Industrial Mathematics would be physics or mathematics. There were only two

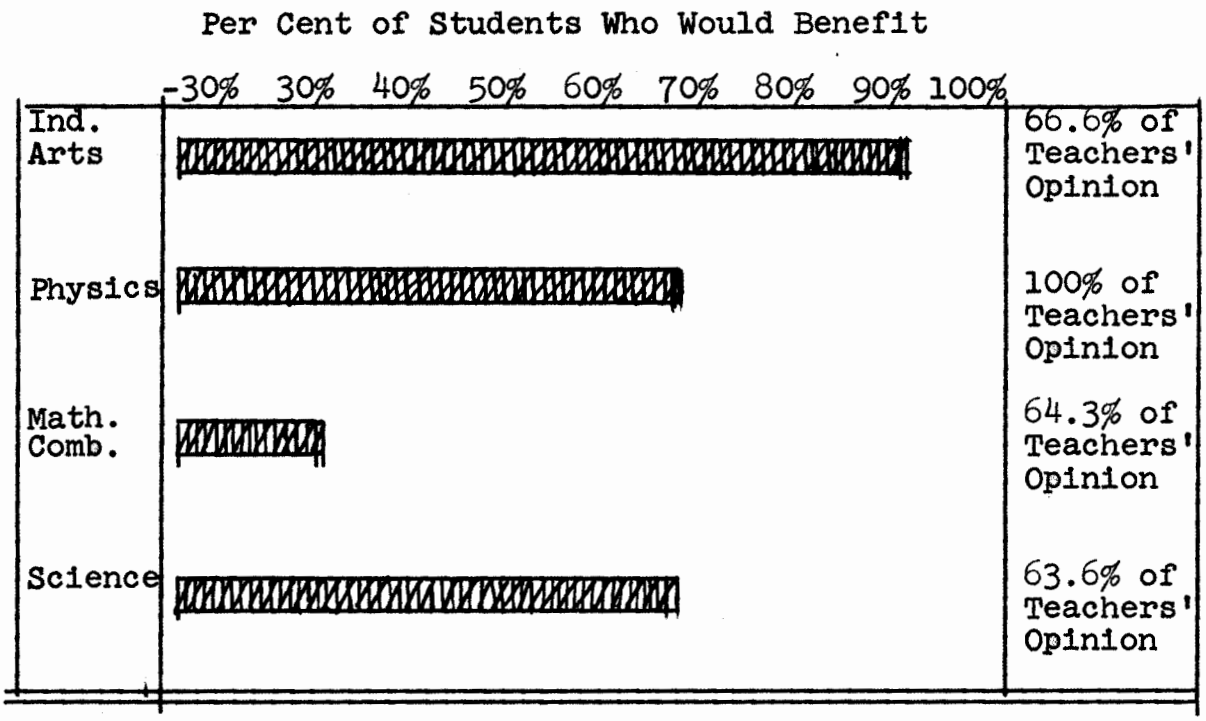

FIGURE I

TEACHERS' OPINION OF INDUSTRIAL MATHEMATICS' BENEFIT IN RELATED SUBJECTS*

* NOTE: Ind. arts teachers' opinions used regarding ind. arts, physics teachers' opinions used regarding physics, etc. Opinions represent the average of the figures given by the majority of teachers in each area.

high school physics teachers in the Inglewood district. One believed Industrial Mathematics would benefit 80 per cent of the students who enrolled in his classes. The other believed Industrial Mathematics would benefit 60 per cent of his students (Figure 1). This is a very favorable report, although of course the fact that only two teachers were included in the survey limits the validity of the answer.

Taking the mathematics area as a whole, 50 per cent of the teachers believed Industrial Mathematics would benefit less than 30 per cent of their students. The rest of the teachers were evenly divided between the range from 30 per cent to 80 per cent beneficial (Figure 1). This is a rather surprising result, especially considering the fact that 85 per cent of these same teachers still thought the class should be continued.

Originally, the possibility of a misinterpretation of the question was considered. The questionnaire read: "Do you believe that Industrial Mathematics, as outlined above, would benefit students who enroll in your class? What percentage?" It was felt the teachers might have misconstrued the question to mean: "What percentage of benefit would Industrial Mathematics be to all your students?" instead of "What percentage of students would benefit?" as was intended. In order to be certain this had not happened, those teachers whose answers indicated they might possibly have misunderstood were contacted personally. Through informal oral questioning

it was established that the original questionnaire was not misinterpreted.

The reason for the rather unfavorable opinion regarding the benefits of Industrial Mathematics to students taking other mathematics was found to be more a result of several of the mathematics teachers' idea that Industrial Mathematics is not very closely related to algebra, geometry, and trigonometry. As a whole, the mathematics teachers teaching general mathematics classes gave more favorable opinions of Industrial Mathematics than those teachers instructing algebra, geometry, and trigonometry. Also, there was some question on the part of the mathematics teachers regarding the placement of Industrial Mathematics under the industrial arts department. Some mathematics teachers inferred that because the Industrial Mathematics course was not taught through the mathematics department it would not be taught according to the proper methods.[1]

Teachers in the science department gave a generally favorable report regarding the value of Industrial Mathematics. Better than 90 per cent felt it was valuable enough to be retained (Figure 1) and 81.8 per cent could see similar value in a practical physics or applied mechanics course

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1. The Industrial Mathematics teacher at one high school (Morningside) is not connected with the mathematics department. He is an industrial arts teacher. At the other high school (Inglewood) the Industrial Mathematics teacher is a member of the mathematics department.

in high school. The majority felt that only about 20 per cent of the high school boys were capable of handling high school physics, algebra, geometry, and trigonometry. As a result, there would seem to be a definite need for electives that serve as practical and useful substitutes.

As a summary of the opinions of teachers in related fields in both high schools, 38.5 per cent believed Industrial Mathematics would benefit 80 per cent or more of their students. Ninety two and three tenths per cent of the teachers felt Industrial Mathematics should be maintained in the curriculum. Eighty seven and two tenths per cent could see the value of a similar course in practical physics or applied mechanics. The greatest number of them felt that only about 20 per cent of the high school boys could handle a "straight academic schedule" of physics, algebra, geometry, and trigonometry. In short, the teachers of related subjects in the Inglewood Unified School District believe Industrial Mathematics is a valuable course and should be continued as a part of the school curriculum.

Since the Industrial Mathematics teachers themselves would be inclined to give prejudiced answers, their opinion of the value of the course to related subjects has been mentioned last. However, the fact that the teachers of the course are most familiar with its purposes and values means their opinion cannot be discounted. Both teachers who are currently teaching Industrial Mathematics (60-61) and those

who are still in the district but are not currently teaching Industrial Mathematics were questioned. One hundred per cent of the Industrial Mathematics teachers felt the course was very valuable to the majority of the students enrolled. Of those teachers who also taught other industrial arts courses, two-thirds felt they noticed a transferral of learning from Industrial Mathematics fairly often; the remaining third said they noticed the transferral often.

In questioning the Industrial Mathematics teachers, some interesting sidelights were presented. One of the teachers had not taught the course for eight years. His questionnaire indicated the course had been taught in the past to a more specialized group of students, namely, those majoring in industrial arts, while the current trend is to allow a cross-section of male students to take the course.

The Industrial Mathematics class was discontinued at Morningside High School because of a lack of student interest and the lack of a qualified teacher approximately every other year. It was resumed again full time in 1959. At that time, apparently, the counselors decided to allow students from all areas to enroll. The questionnaire sent to the Industrial Mathematics teachers also shows that a lower academic quality* of students has enrolled since 1959. This is based on the former teacher's indication that his students

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* NOTE: The academic quality of the student is based chiefly on I.Q. scores and grades received in the past.

were average and the current teachers' indication that their students are slightly below average. Also, the current teachers indicated only 10 per cent to 25 per cent were capable of handling high school algebra while the former teacher indicated 50 per cent of his students were capable.

The all-inclusive opinion of the Industrial Mathematics teachers regarding Industrial Mathematics was that it is valuable to related subjects. They justified their opinion by stating that in other courses they taught they noticed a definite carry-over from Industrial Mathematics.

III. EVALUATION BY STUDENTS

Of all students answering the questionnaire (A: Appendix), 73.8 per cent reported that they believed Industrial Mathematics helped them in other industrial arts courses. This is a good percentage, especially considering that another 18.5 per cent said they took no other industrial arts courses at the same time or after completing Industrial Mathematics.

In answer to the question of whether or not Industrial Mathematics helped in mathematics courses taken after completing Industrial Mathematics, of the students who indicated they had taken further mathematics courses, 80.9 per cent reported they believed Industrial Mathematics helped them in algebra. Only 11.9 per cent indicated they felt Industrial Mathematics helped them with general mathematics. These

percentages total more than 100 per cent because a few students took more than one mathematics course at the same time or after completing Industrial Mathematics.

Only 42 out of a total of 126 students polled indicated they took other mathematics courses after or at the same time they took Industrial Mathematics. Also, although algebra received by far the highest percentage of mention, this does not necessarily mean that Industrial Mathematics is more helpful for algebra students. It indicates, rather, that the mathematics most commonly enrolled in after Industrial Mathematics is algebra.

It might be mentioned here that the two high schools in the Inglewood Unified School District do not have a uniform ruling regarding enrollment in Industrial Mathematics. Morningside High School requires a year of mathematics before Industrial Mathematics and does not allow Industrial Mathematics to be substituted for the basic requirement of one year of mathematics before graduation. At Morningside all Industrial Mathematics students have already completed one year of mathematics of some kind. They are not so likely to take more mathematics courses after Industrial Mathematics. Students at Inglewood High School, on the other hand, are not required to have a year of mathematics previous to Industrial Mathematics, and the questionnaire (A: Appendix) showed more Inglewood High School students took other mathematics courses later. However, since students from

Inglewood High School are also allowed to use Industrial Mathematics to fulfill the basic one year mathematics requirement, presumably, many students who felt they were weak in mathematics took no other mathematics before or after Industrial Mathematics.

Perhaps one of the simplest evaluations of the students' over-all opinion of Industrial Mathematics may be found in the answer to this question: "Would you recommend Industrial Mathematics to other students?" (Quest. A: Appendix). Of the 126 students questioned, 82.5 per cent recommended Industrial Mathematics. Only 3.9 per cent did not or would not recommend Industrial Mathematics to other students, and 13.6 per cent remained uncertain (Figure 2).

IV. EVALUATION SHOWN BY STATISTICS

In an effort to discover an actual statistical difference between the grades of students who had completed Industrial Mathematics and those who had not, two random samplings of students were taken from the industrial arts area. One group was comprised of students who took Industrial Mathematics, (test group), the other of students who did not, (control group). Their grades were compared in the industrial arts area the year before the test group took Industrial Mathematics, the same year they took Industrial Mathematics, and the year after they had completed Industrial Mathematics. In order to show the comparison of the students,

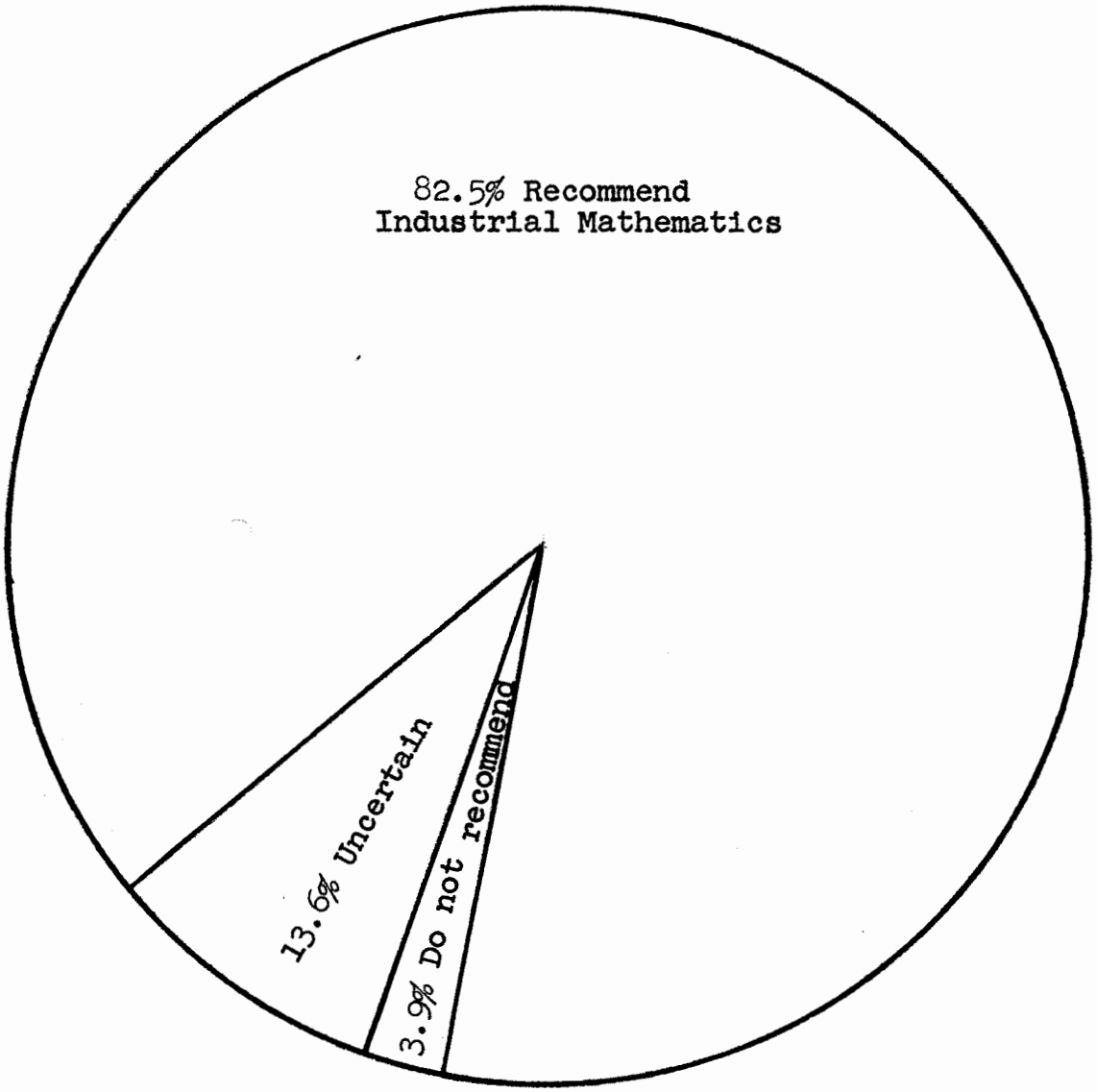

FIGURE 2

PERCENTAGE OF STUDENTS RECOMMENDING INDUSTRIAL MATHEMATICS TO OTHER STUDENTS

(Results from 126 Students Questioned)

their I.Q. and D.A.T.* scores were also compared (Table I).

The results of this comparison were truly surprising. Although it so happened that the control group had slightly higher scores on the I.Q. and D.A.T. tests and very slightly higher grades before the test group took Industrial Mathematics, the group that took Industrial Mathematics passed the control group the year they took Industrial Mathematics and managed to move ahead an even greater margin the second year of the comparison. Students who took Industrial Mathematics showed a gain of 1.1 grade points while enrolled and after completing Industrial Mathematics. The control group in comparison, showed a loss of .02 in their grade point average over the same period (Table I).

Because of the difficulty in gaining access to the records of the students and because of the limitations of this paper, a total of 50 students were all that were compared. It is conceded that this limits to some extent, the validity of the study. Even so, the results seem to be significant. The value of Industrial Mathematics, at least in the related area of industrial arts, appears to be indisputable.

V. SUMMARY

Chapter III may be briefly summarized by stating that many educators are in favor of a course such as Industrial

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* NOTE: D.A.T. = Differential Aptitude Test

TABLE I

A COMPARISON BETWEEN STUDENTS IN THE INDUSTRIAL ARTS DEPARTMENT WHO DID AND DID NOT TAKE INDUSTRIAL MATHEMATICS

	TWENTY FIVE STUDENTS WHO TOOK IND. MATH.	TWENTY FIVE STUDENTS WHO DID NOT TAKE IND. MATH.
I.Q.	91.24	102.1
D.A.T.* MATH PERCENTILE	25%	25.4%
D.A.T. MECH. PERCENTILE	26%	28%
AVERAGE I.A. GRADES** BEFORE I. MATH.	3.2	3.02
AVERAGE I.A. GRADES DURING I. MATH	2.94	
AVERAGE I.A. GRADES AFTER I. MATH	2.1	3.04

* Differential Aptitude Test

** The grades are based on a 1 to 5 basis

1 is the equivalent of an A
2 " " " " a B
3 " " " " " C
4 " " " " " D
5 " " " " an F

Mathematics in view of its value to related subjects. Teachers of related subjects in the Inglewood Unified School District feel that Industrial Mathematics is worthwhile. Though there is a good deal of difference of opinion concerning the amount of value of Industrial Mathematics, the teachers generally agree that there is some transference of learning from Industrial Mathematics to related subjects. Most teachers place the amount of transference at a fairly high level.

Students who have taken Industrial Mathematics expressed favorable opinions of the class. Statistics show that in the field of industrial arts, at least, there is a real improvement in grades of the students who take Industrial Mathematics. So, Industrial Mathematics appears to meet the requirement that it be helpful to the student in related subjects.

In addition, due to its practical application, Industrial Mathematics qualifies as one of the subjects that does exercise "holding power," tending to keep students enrolled who might otherwise drop out of high school. This in itself may be reason enough to continue Industrial Mathematics in the high school curriculum.

CHAPTER IV

THE VALUE OF INDUSTRIAL MATHEMATICS TO EDUCATION IN GENERAL

A lot has been said about the "well rounded" education. Presumably, everyone should know a "little bit about a lot." Educators defend this attitude in a number of ways which generally boil down to the need to know how to get along in the world and with our fellow man. Lucien Kinney and Richard Purdy express it this way:

> The responsibilities of a citizen, in a democracy such as ours, are manifold and important. In public affairs, he must make decisions, or appraise those made by his agents, on local, national, and international issues. The history of democracies records many instances where public leaders have been forced, through pressure of an uninformed public, into activities they knew to be unwise. It records few instances where farseeing policies could be carried through against public ignorance and prejudice (5:5).

This chapter, then, has been devoted to an investigation of the merits of Industrial Mathematics to education in general. Again the problem has been approached from a number of angles. The need for such a course, as indicated from library findings, was investigated. Those in local industry who would be prospective employers of high school graduates were asked to evaluate the course from their standpoint. In addition, the opinions of teachers and counselors were taken into consideration.

I. LIBRARY FINDINGS

A great many educators make a special effort to stress the importance of offering courses of a practical nature. Their reasoning is varied, but again the crux of the matter seems to be that the more practical and usable the educational background, the better the resulting citizens are likely to be. For example, Kinney and Purdy, in Teaching Mathematics in the Secondary School say:

> Not only because a large proportion of our activities and problems are mathematical in their nature but also because mathematics is basic to a large number of branches of human knowledge, mathematical competence is essential to citizenship competence (5:6).

Another pair of noted educational authorities present a similar opinion. In their text, Making Arithmetic Meaningful, Leo Brueckner and Foster Grossnickle say, "Actual practice in solving problems of daily life that are of concern to the pupils is a most valuable type of experience in democratic living" (8:5). Again they state, "The more closely the learning of arithmetic is integrated with its uses in the affairs of daily life, the more productive the experiences will be (8:5). Brueckner and Grossnickle present their argument in still another way:

> The two primary objectives of the modern arithmetic program are (1) to develop in the learner the ability to perform the various number operations skilfully and with understanding, and (2) to provide a rich variety of experiences which will assure the ability

> of the pupil to apply quantitative procedures effectively in social situations in life outside the school (8:2).

An interesting booklet entitled Careers in Mathematics, published by the National Council of Teachers of Mathematics, presents another argument in favor of courses such as Industrial Mathematics:

> In our rapidly changing world, mathematics is growing faster than ever before. While mathematicians are producing a flood of new ideas and results, applications of mathematics are being found everywhere (9:1).

Gertrude Barber, in an article in the N.E.A. Journal titled "Guiding the Low-Ability Student," concurs with the opinion that there is a need for courses like Industrial Mathematics:

> Unless secondary schools provide young people with skills that can tie them into the adult working world, human resourses will be wasted and a great deal of individual unhappiness and privation can result. Unemployable persons increase relief rolls and are candidates for mental illness, delinquency, and crime.
>
> Clearly, the schools must do more to help those who otherwise will graduate with nothing to sell in the labor market. This job will involve basic counseling to show these students that labor, whether it is physical or mental, can be dignified and can make a contribution to our society (10:38).

While educators speak in favor of such a course as Industrial Mathematics and seem to believe it is essential to the modern curriculum, not all feel it is advisable for students in general. Walter Hart, Veryl Schult, and Lee Irwin, in their combined effort, Mathematics in Daily Use,

caution that care should be taken to present particular areas of mathematics only to those pupils who need it (11:4). In their opinion, then, the student who already possesses a thorough background of general mathematics would not need the added training of exact practical applications as offered in Industrial Mathematics. These experiences he would be able to grasp for himself.

Others argue for courses such as Industrial Mathematics because of their value to the "not so bright" student who is entitled to an education that for him is just as good and useful as the brighter college-bound student's education. In other words, the less-gifted student is entitled to equal opportunities for an education that will serve him well. Harold Hand, in Principles of Public Secondary Education, says, "Complete equality of educational opportunity has long been a recognized goal of our society" (6:57). He also states:

> We believe that access to the good life should be equally available to everyone. Since the good life is equally accessible to all only if all young people have an equal opportunity to learn whatever must be learned in order to live the good life, our public secondary schools should be designed to serve equally well all the educable children of all the people (6:56).

In Hand's opinion, the schools are failing to meet the needs of those pupils who are not particularly talented and will not be going on with their education:

> On the average, the less competent a pupil has shown himself to be in meeting school tasks, the more quickly he is released to face adult problems. Those who will be least able to acquire socially

> useful habits, information, and points of view without formal instruction are those to whom the school has given the least attention (6:83).

He feels the lack of practical courses suitable to the general education of these less competent students is definitely one of the main contributing factors in student drop outs:

> It is principally because the typical high school has made only some of the necessary adjustments in its program that such grossly disproportionate numbers of pupils whose academic aptitude is low leave school before graduation. Too commonly such pupils are offered only the kind of school subjects which have little meaning for them (6:89).

Harold Rugg and William Withers, in Social Foundations of Education, also believe that education should be planned to meet the needs of all the people. They say, "The American people believe that the success of democracy rests upon the education of all the people" (12:25).

Library findings regarding the value of Industrial Mathematics to education in general, then, have indicated that a need for such courses exists.

Two main thoughts have been presented. One, a practical course such as Industrial Mathematics is valuable from the standpoint of helping people better understand each other and thus become better citizens. This attitude would indicate that whatever area the student eventually went into for his life's work, he would benefit from understanding about the work of others.

The second thought presented is that the less gifted

students in particular benefit from the addition of subjects such as Industrial Mathematics. Giving them something practical to use will help them become better citizens. Also, the thought has been presented that the less gifted students have as much right to the kind of education that will benefit them as do the more brilliant students. In short, library findings show a need for Industrial Mathematics and similar courses in the high school curriculum as an aid to education in general.

II. PROSPECTIVE EMPLOYERS' EVALUATION

Although, for the most part, prospective employers tended to evaluate Industrial Mathematics from the point of its direct value to their specific job areas, it is also true that as a whole the employers felt that the practical application of mathematics is one of the areas in which most high school graduates are weak.

The president of one of the industries took time to send along a personal letter expressing his views on the value of Industrial Mathematics. The following is an excerpt from this letter from Mr. O. P. Grani, President, O. P. Grani, Inc.:

> Our experience with fellows we have hired right out of high school is that their practical knowledge has been very meager as far as factory or shop use is concerned. Anything your thesis can do to stir the proper authorities towards a more practical use of mathematics would certainly be of great interest to all types of industry (13:1).

Mr. Grani's letter more or less summarizes the findings of the questionnaire sent to prospective employers (Quest. C: Appendix).

Also of special interest was the fact that 91.1 per cent of the prospective employers contacted by questionnaire felt that Industrial Mathematics would be either valuable or very valuable to those students who plan to take more specialized technical training before seeking employment. The prospective employers have not agreed with the views of the educators covered under "library findings" who felt courses such as Industrial Mathematics were of value chiefly for the student who would not be continuing his education after high school.

According to the prospective employers' opinions, then, Industrial Mathematics should not be restricted to industrial arts majors. It would be valuable, too for those who plan to take more college and other technical training.

One hundred per cent of the prospective employers interviewed felt the course would be helpful to potential employees who did not have school training beyond high school. Also, better than 85 per cent felt Industrial Mathematics would be of greater value to non-specialized or semi-skilled employees than algebra or geometry (Figure 3).

III. TEACHERS' AND COUNSELORS' EVALUATION

As was previously mentioned (Ch. 3:6) teachers

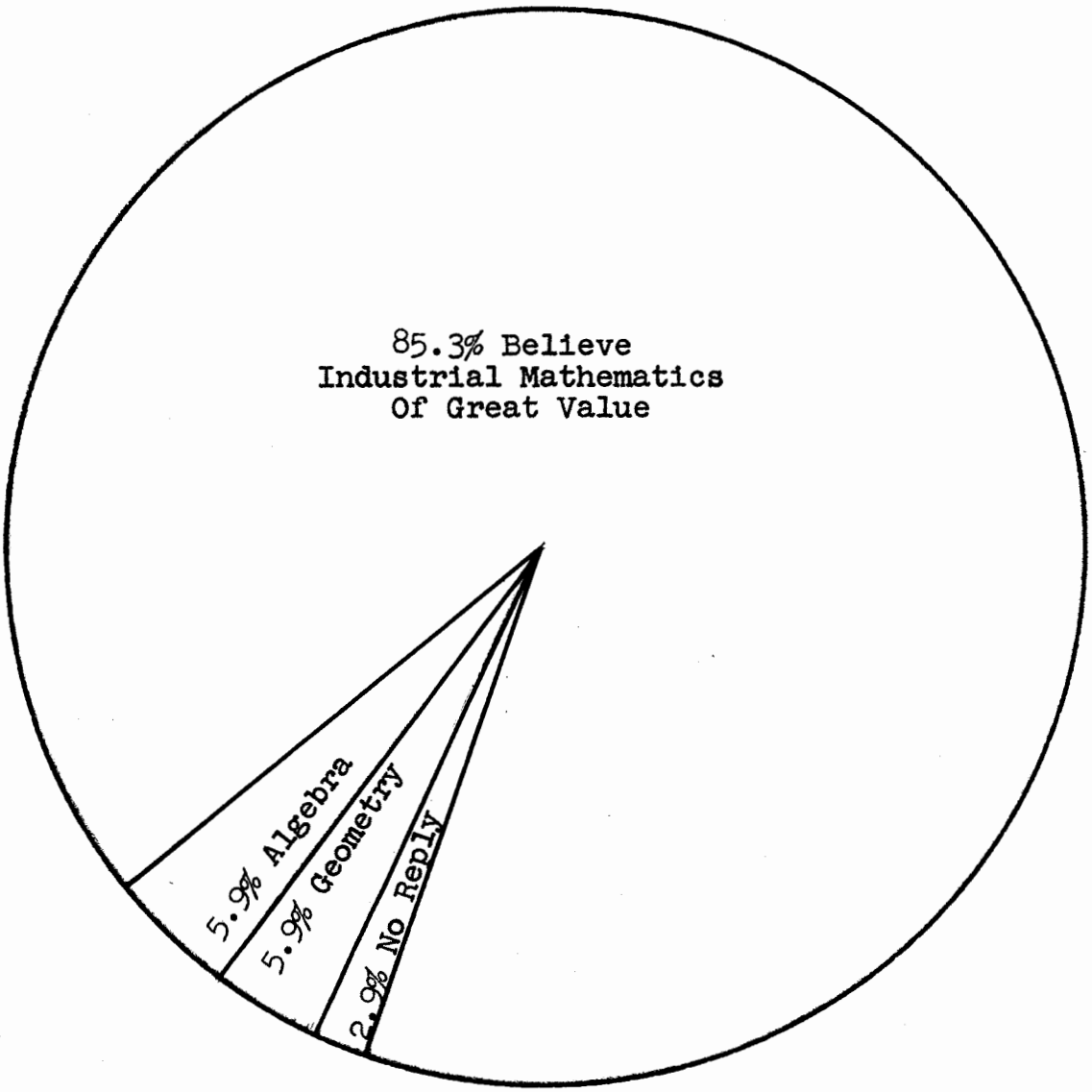

FIGURE 3

EMPLOYERS'* OPINIONS OF THE RELATIVE VALUES OF INDUSTRIAL MATHEMATICS, ALGEBRA, & GEOMETRY TO NON-SPECIALIZED OR SEMI-SKILLED EMPLOYEES

* 34 local industries represented

questioned from both high schools in the Inglewood Unified School District were 92.3 per cent in favor of keeping Industrial Mathematics in the curriculum in spite of the current trend toward "required college preparatory" classes.

Another teacher in the Los Angeles area, Dr. Gordon Funk, Director of Industrial Arts Education in the Secondary Schools of the City of Los Angeles, substantiated this opinion when he stated that even though currently there is a big push to get many youngsters into college, the fact remains that currently in the Los Angeles area only one-third of the high school graduates actually receive B.A. degrees or the equivalent. The balance of the graduates either go directly into the labor force or drop out of college before they have completed their planned courses (14).

The figure of one-third of the high school graduates becoming college graduates is high in comparison to the national average. It must also be taken into consideration that a good many of the third who eventually receive college diplomas spend years working in the labor force either part-time or full-time before they finally receive their degrees. This is particularly true in the industrialized areas such as Los Angeles, where it is more or less common practice for the employer to pay the way for promising employees to get degrees.

Often the employee is allowed to work half-days in order to attend regular classes. In addition, night classes

are highly popular and "extended day" classes are well attended by the working force. This means that even the high school students who do eventually receive college degrees may find themselves in need of a good practical background such as Industrial Mathematics offers, in order to support themselves while they are working toward their degree. In fact, the very possession of a good basic understanding of Industrial Mathematics might help convince an employer that a certain employee is one who deserves to have his way to college paid by the company.

Counselors in the Inglewood Unified School District seem to be changing their opinion of Industrial Mathematics. Questionnaire A (Appendix) was sent to students who had taken Industrial Mathematics during the last three years. One of the questions asked was "Whose idea was it that you take Industrial Mathematics?" In the school year 1958-59, no students reported that a counselor had recommended Industrial Mathematics. In the year 1959-60, 30.5 per cent of the students reported that their counselor had recommended Industrial Mathematics. The remainder of the students had enrolled of their own accord or at the suggestion of parents or friends.

These figures may indicate that the counselors are becoming more convinced of the values of Industrial Mathematics. Also, a greater cross-section of students is enrolling in Industrial Mathematics rather than a concentration of

industrial arts majors, as in the past. These two factors, combined, indicate that the counselors are recommending Industrial Mathematics to more students with more varied backgrounds.

IV. SUMMARY

If anything, it seems that Industrial Mathematics is even more valuable to education in general than to specific related subjects. This finding may be due in part to the tendency to feel that since any learning is of some value, if the specific value cannot be named it must be of value to "education in general."

The facts remain, however, that well-known educators believe there is a need for courses such as Industrial Mathematics. Prospective employers from local industry are particularly enthusiastic about Industrial Mathematics. They maintain it would benefit the students they hire from high school and also those who go on to college or other technical training and eventually get into industry.

Although the findings in Chapter III show that teachers were not always able to see a direct use for Industrial Mathematics in related subjects, they were in favor of keeping Industrial Mathematics in the curriculum in spite of the trend toward "required college preparatory" classes. Counselors are currently recommending Industrial Mathematics not only to industrial arts majors but to other students as well.

These facts indicate that teachers and counselors believe Industrial Mathematics to be of value to a student's general education.

CHAPTER V

THE VALUE OF INDUSTRIAL MATHEMATICS IN DIRECT RELATION TO FUTURE EMPLOYMENT

In the light of what has previously been said about the need for courses such as Industrial Mathematics to aid education in general (Ch. IV) and the conclusion that Industrial Mathematics is of particular benefit as a practical aid to students who do not plan to further their education after high school, the next question raised is, "How valuable is Industrial Mathematics in direct relation to future employment?"

Several approaches have been made in seeking an answer to this question. The first and most logical place to look for an answer to this question is from the prospective employers themselves. In addition, library research on the subject has been done. Graduates of Industrial Mathematics who are now employed have been asked opinions regarding the value of the class. Teachers have also expressed their views. All these have been taken into consideration in the final conclusion regarding the value of Industrial Mathematics in direct relation to future employment.

I. PROSPECTIVE EMPLOYERS' VIEWS

Although the questionnaire (C:Appendix) sent to pro-

spective employers indicated the employers were overwhelmingly in favor of Industrial Mathematics and felt it would definitely benefit their employees (Table II), the mere fact that a prospective employee took Industrial Mathematics would apparently be of little importance. This deduction is based on the replies of employers to the question, "Do you check prospective employees' high school course records before hiring them?" Only 20 per cent replied "always", 55.9 per cent said "occasionally", and 23.5 per cent said it was "unnecessary" to check.

On the basis of those findings it appears to be up to the job applicant to make a point of the fact that he has taken Industrial Mathematics, and no doubt he would be judged more on how well he applied his knowledge of Industrial Mathematics than on the mere fact that he had completed the course.

The prospective employee who is best able to apply his knowledge of mathematics on such tests as most non-specialized or semi-skilled workers receive before being hired would naturally be most likely to get the job. Furthermore, generally, the employee who does his job best is the one promoted most quickly.

The conclusion would be, then, that a background of Industrial Mathematics would give a prospective employee an "edge" in competition for a job and would help him advance in his work. However, it is up to the individual to make

TABLE II

EMPLOYERS'* EVALUATION OF INDUSTRIAL MATHEMATICS

VALUE TO EMPLOYEES HIRED FROM HIGH SCHOOL		VALUE TO EMPLOYEES WITH TRAINING BEYOND H.S.	
Very Valuable	52.9%**	Very Valuable	52.9%
Valuable	47.1%	Valuable	38.2%
Slight Value	0.0%	Slight Value	8.8%

* 34 Local Industries Represented

** Each figure represents per cent of all employers who indicated degree of value.

use of what he has learned. The fact that a prospective employee "took" a course in Industrial Mathematics would probably be of little value in getting a job. The fact that the prospective employee took the course and applied it would be of great value.

It is interesting to note that 34 out of 50 local industries (or 68 per cent) replied to the questionnaire. Many of these industries are tremendous in size, such as Douglas Aircraft Company, Incorporated and Hughes Aircraft Company, Incorporated. The fact that such a good percentage of returns was received indicates that the employers really are interested in the high school education of their workers, both skilled and unskilled. Many took the extra time and effort to add their own suggestions regarding material that should be covered in Industrial Mathematics. A complete list of companies contacted and some of their suggestions are included in the Appendix of this paper. This information in itself could form the basis of another study into the possible need to "up-date" the material covered in Industrial Mathematics.

II. LIBRARY FINDINGS

There seems to be no doubt in the minds of educators that Industrial Mathematics and similar courses are of great value to the student planning to go into industry. This is clearly stated by William Micheels and Wesley Sommers in

The Minnesota Plan for Industrial Arts Teacher Education:

> The typical worker of tomorrow will require much more technological knowledge related to the functional elements of science and mathematics as these apply to the various occupations (7:3).

In the booklet, Careers in Mathematics, another view is presented.

> If you are planning to be a skilled workman in one of the apprenticeable trades, a good knowledge of mathematics, especially as applied to your trade, will help. One or two years of general mathematics, and for some jobs a year or more of shop mathematics, will give you a good start. But if you can include algebra, geometry, and trigonometry, you are likely to find more doors open (9:18).

This idea, that "shop mathematics" or Industrial Mathematics," as the course is titled in this paper, should be taught after general mathematics has been the thought behind the Morningside High School requirement of one year of mathematics before Industrial Mathematics. The other high school in the Inglewood Unified School District, Inglewood High School, does not require any mathematics before Industrial Mathematics and allows Industrial Mathematics to substitute for the basic mathematics requirement of one year. Apparently there is a difference of opinion as to the values of Industrial Mathematics among the counselors and administration at the two schools. Inglewood High School is using it more as a general education subject while Morningside High School considers it to be of a more specialized nature.

Though these two schools do not seem to agree, this

does not necessarily mean that one school is more correct in its thinking than the other. The fact is, Inglewood High School is in an area of Inglewood where more students come from typical working class families, and the majority of students at Morningside High School come from a professional or semi-professional type background. This means that a greater number of students from Inglewood High School will eventually find a more practical use for Industrial Mathematics, while a smaller group of more specialized students from Morningside High School will find a direct use of it.

Certainly the student who does not use Industrial Mathematics in a direct way after high school graduation has not wasted his time in taking the course. The Guide for Industrial Arts in California points this out quite clearly:

> Twentieth century America is dominated by industry. The educated man of today must be informed regarding the effect of this and all other elements of his environment. Industrial arts is that part of the total educational program which provides opportunity for the study of man and industry. Through participation in typical experiences in industrial processes and techniques; industrial arts enriches other instructional fields such as mathematics, science and language arts by bringing theory and practice closer together through illustrations and practical examples which are industrial in nature; and discovers and develops personal aptitudes, interests, abilities, self reliance, good judgment, and resourcefulness through problem-solving and self expression in an environment related to industry. Industrial arts education is designed to help prepare individuals to meet the requirements of today's culture (15:3).

The problem considered in this chapter, however, is

the value of Industrial Mathematics in direct relation to future employment. Keeping that in mind, as well as the particular financial positions of the typical students from each of the high schools, it appears that Industrial Mathematics would have more direct use for the students from Inglewood High School. They are more likely to have to work their way through college if they attend or will more likely become part of the permanent working force. This is speaking for the majority only, of course. Certainly many students from Inglewood High School have the academic ability and financial means to go directly into college and aim toward a profession. Many students who attend Morningside High School do not have the academic ability or financial means to go on to college.

Industrial Mathematics would be more important in direct relation to employment in some schools than others. The type of area being served by the school would enter in. Naturally, Industrial Mathematics is designed to serve the students living in an industrial area. In an agricultural area, elective courses combining mathematics and agriculture would prove more valuable. Also to be considered in the evaluation of Industrial Mathematics is the typical background of the students being served by the school. If the school happens to cater primarily to students from the higher income families, there will be less need for courses such as Industrial Mathematics, which helps equip the student for

earning a living immediately upon graduation from high school.

This conclusion by no means indicates that Morningside High School should not continue Industrial Mathematics. Obviously, any high school with an enrollment of 1,875 students is bound to have enough of a cross-section to justify both purely academic and practical education courses in the curriculum. As has already been stated, a basic American concept is "equality of opportunity for everyone." Each student has a right to as good an education for his personal needs as can possibly be provided. The point is, if lack of funds forced the school district to discontinue Industrial Mathematics at one of the high schools, Morningside High School would be the logical choice.

III. OTHER FINDINGS

According to teachers in related fields, Industrial Mathematics is valuable and should be maintained in the curriculum. Better than 55 per cent of the teachers questioned felt that 20 per cent or less of the boys in high school were capable of handling the academic subjects of high school physics, algebra, geometry, and trigonometry. This would indicate that the teachers themselves do not feel their students are of the caliber necessary to make college graduates. Surely a student capable of earning a college degree would be capable of handling practically any high school subject if he so desired. Obviously, if the majority of

high school graduates are not going to finish college, they will be obtaining jobs in industry and other areas where a practical mathematics background such as Industrial Mathematics offers will be useful.

The teachers of Industrial Mathematics in the Inglewood School District feel that only a small percentage of the students enrolled in Industrial Mathematics are capable of handling high school algebra. For this reason it would seem that most of the students who take Industrial Mathematics would not go on to college and would be going directly from high school into various types of work or trade schools. On that basis the Industrial Mathematics course would be particularly valuable.

Of those students who received questionnaires and stated they are now employed either full-time or part-time, (a total of 68) 29.4 per cent said Industrial Mathematics did help them get their jobs and 45.5 per cent said Industrial Mathematics is helping them do their job better. Twenty-two per cent were uncertain about whether or not Industrial Mathematics helped them get their jobs, and 20.5 per cent were uncertain whether or not Industrial Mathematics was helping them do their jobs better. Forty-eight and one-half per cent said Industrial Mathematics did not help them get their jobs, and 33.8 per cent said Industrial Mathematics was not helping them do their job better (Table III).

TABLE III

EMPLOYED STUDENTS'* EVALUATION OF ON-THE-JOB BENEFITS FROM INDUSTRIAL MATHEMATICS

HELPED GET JOB		IS HELPING DO JOB BETTER	
Yes	29.4%	Yes	45.5%
No	48.5%	No	33.8%
Un-Certain	22.0%	Un-Certain	20.5%

* 68 students of 126 questioned were currently employed, full or part-time.

This is not a particularly high recommendation for Industrial Mathematics. There is a qualifying factor in these responses, however. Actually, a majority of the jobs represented were part-time jobs held by students still in high school. They were not particularly related to the kind of work the students will eventually undertake. Possibly, too, the students have underestimated the value of the course. This seems to be the case in view of the contrasting opinions expressed by the potential employers.

IV. SUMMARY

Prospective employers believe Industrial Mathematics should be maintained in the curriculum as an aid to future employment. They maintain it is valuable to the student who enters industry directly from high school and also to the student who takes further training before going into industry. At the same time the majority of employers state that they check high school course records only occasionally before hiring. Therefore, it is up to the job applicant to make a point of his background and show his abilities on such tests as he has to take in order to get the job.

Educators feel courses such as Industrial Mathematics are extremely helpful in relation to future employment. Yet this must be tempered with a consideration of the particular area and particular school. Industrial Mathematics is infinitely more valuable in some areas than others. Right

within the Inglewood Unified School District, one of the two high schools appears to have a greater need for Industrial Mathematics and similar courses because of a greater enrollment from families of the working class who have less financial means for furthering their childrens' educations.

Teachers in related fields indicated they believe Industrial Mathematics to be important for future employment. Better than half of the teachers questioned felt that 20 per cent or less of the boys in high school were capable of handling the academic subjects of physics, algebra, geometry, and trigonometry. Therefore, these same students who could not handle the more academic mathematics courses would not be completing college and would be obtaining jobs in industry.

The students questioned who are now holding jobs were not especially favorable in their opinion of Industrial Mathematics in direct relation to employment. Many of them were not certain whether Industrial Mathematics helped them obtain their jobs; many of them were not certain whether or not Industrial Mathematics was helping them do their job better. Actually, only 29.4 per cent said Industrial Mathematics helped them get their job, and 45.5 per cent said Industrial Mathematics is helping them do their job better. This is a rather contradictory opinion in view of the high favor of Industrial Mathematics expressed by prospective employers.

CHAPTER VI

SUMMARY AND CONCLUSIONS

In order to study the benefits gained from Industrial Mathematics by the students in the Inglewood Unified School District, something of a geometric approach has been used. Starting from several varied points, an attempt has been made to plot a single "unknown point," the actual value of Industrial Mathematics.

The first approach to the problem consisted of library research. The reading covered disclosed that the majority of educators were in favor of courses of a practical nature, such as Industrial Mathematics. Although many of them mentioned the direct application of the course toward getting employment after high school graduation, other educators looked upon such courses as Industrial Mathematics as a means to broaden the general education of students. They felt the course was good because it taught mathematics in a way that the student could see was practical. Several educators were concerned with this broader viewpoint. To them, Industrial Mathematics is more valuable as a way to teach mathematics rather than as a direct help toward finding a job. This is expressed in Brueckner and Grossnickle's book, Making Arithmetic Meaningful:

It has been demonstrated that learning proceeds

> best when it takes place in social situations that are meaningful to the learners (8:11).

Still other educators look upon Industrial Mathematics as a good course because it helps provide equality of education. They feel the student who is not capable of other more academic learning should have the opportunity to take something that will be of benefit. Their reasoning is summarized by Harold Hand in Principles of Public Secondary Education:

> The goal of our public schools should be to make the best in education available to every American child on completely equal terms (6:79).

Neither of these purposes is generally considered primary in introducing Industrial Mathematics to the curriculum. The main purpose, as stated by Robert Kelly, in An Instructional Guide for Industrial Mathematics I, Los Angeles City Schools, is as follows:

> Industrial Mathematics I provides for the development of specialized mathematical understandings and computational efficiency needed by technicians and skilled workers (15:6).

If Industrial Mathematics achieves value in a general sense as well as in the specific area for which it is intended, so much the better.

Since the first approach to the problem revealed there were several values to be derived from Industrial Mathematics, the work was divided into a study of the three main values: the value of Industrial Mathematics in related subjects, the value of Industrial Mathematics to education in general, and the value of Industrial Mathematics in direct relation to

future employment.

Those students who were taking or had completed Industrial Mathematics seemed logical persons to question regarding the merits of the course. In addition, teachers of Industrial Mathematics and teachers of related subjects seemed logical persons to question. Still another group, perhaps the most likely to help determine the values of Industrial Mathematics, was prospective employers of high school graduates selected from local industry. By sending separate questionnaires to these four groups, it was possible to get quite an accurate "opinion-type" evaluation of Industrial Mathematics as well as some facts and figures to support the opinions.

In order to gain more statistical proof regarding the value of Industrial Mathematics, a comparison study was made of the records of 25 students who had completed the course in Industrial Mathematics with 25 students who otherwise took similar courses but did not take Industrial Mathematics. Students with similar I.Q.'s and D.A.T. scores were selected to assure a fair comparison.

The results of these various approaches to the problem of the benefits gained from Industrial Mathematics by the students in the Inglewood Unified School District, broken into the three main areas of benefit, will follow.

I. THE VALUE OF INDUSTRIAL MATHEMATICS IN RELATED SUBJECTS

Many educators are in favor of a course such as Industrial Mathematics in view of its value to related subjects. Teachers of related subjects in the Inglewood District showed in their total opinion that they feel Industrial Mathematics is worthwhile for its value in related subjects. They do not agree on the amount of value, but they do agree there is some transference of learning to related subjects; most of the teachers placed the per cent of students who would benefit at a fairly high level (Figure 1:19).

Students who have taken Industrial Mathematics and those now enrolled show a favorable opinion of the value of the course, particularly in relation to other industrial arts courses. Students generally felt it was beneficial and said they would recommend it to other students. Due to its practical application, Industrial Mathematics is one of the courses that exercises "holding power" over students who might otherwise drop out of high school. This in itself may be reason enough to continue Industrial Mathematics in the high school curriculum. If Industrial Mathematics helps keep students enrolled in other classes, it is certainly of benefit.

II. THE VALUE OF INDUSTRIAL MATHEMATICS TO EDUCATION IN GENERAL

Because so many educators have written in favor of Industrial Mathematics and similar classes due to the contribution to education in general, even though the course was originally intended to serve more directly as an aid to those who planned to become technicians or skilled workers, it has been examined for its contribution to education in general.

In addition to the strong arguments presented in the writings of well recognized educators (Ch. IV:32-35), prospective employers from local industry indicated they believed it would benefit those students who go on to college or other technical training before entering industry, as well as those students who go into industry directly from high school (Table II:45).

A greater percentage of teachers indicated they believed Industrial Mathematics was valuable to education in general than to specific related subjects. They were in favor of keeping Industrial Mathematics in the curriculum in spite of the trend toward "required college preparatory" classes.

Counselors are currently recommending Industrial Mathematics not only to industrial arts majors but to other students as well. These facts indicate that teachers and

counselors believe Industrial Mathematics to be of value to a student's general education.

III. THE VALUE OF INDUSTRIAL MATHEMATICS IN DIRECT RELATION TO FUTURE EMPLOYMENT

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One of the facts to be taken into account in evaluating the value of Industrial Mathematics in direct relation to future employment is the location of the school offering the course. Industrial Mathematics is infinitely more valuable in some areas than others. Within the Inglewood School District, one of the two high schools has a greater need for Industrial Mathematics and similar courses because a greater number of the students enrolled there come from families of the working class who have less financial means for furthering their childrens' educations.

Better than half of the teachers questioned felt that

20 per cent or less of the boys in high school were capable of handling the academic subjects of physics, algebra, geometry, and trigonometry. That would indicate that a great number of the high school boys would not be capable of completing college training and would be needing such practical courses as Industrial Mathematics to equip them to hold good jobs in industry without the more formal type of college education.

The students questioned who are now holding jobs were not especially favorable in their opinion of Industrial Mathematics in direct relation to employment. Many of them were not certain whether Industrial Mathematics helped them obtain their jobs, and many of them were not certain whether or not Industrial Mathematics was helping them do their job better (Table III:52). Only 45.5 per cent said Industrial Mathematics is helping them do their job better; 29.4 per cent said Industrial Mathematics helped them get their job.

Summarizing the problem of this paper in one paragraph, it is generally agreed that Industrial Mathematics is valuable and should remain in the curriculum of the Inglewood Unified School District. The degree of value of the course has been measured to some extent. However, if the problems of financing reach the point where some electives must be eliminated from the curriculum, the only truly accurate means of deciding which electives have to go would come from comparing all questioned electives (by studies similar to

this) and then eliminating those electives deemed least valuable.

Another question outside the scope of this paper has been raised. Questionnaire returns from prospective employers (Quest. C:Appendix) contained a number of suggestions of additional practical material which might also be included in Industrial Mathematics. There is a possibility that the material covered in the course needs to be up-dated, with some areas eliminated and others added. This, of course, would involve another study.

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APPENDIX

QUESTIONNAIRE A

TO: STUDENTS WHO HAVE TAKEN INDUSTRIAL MATHEMATICS AT INGLEWOOD OR MORNINGSIDE HIGH SCHOOL

It is important that we have your answers to the following questions in order to make this course of utmost value to you and students who follow you.

PLEASE CHECK APPROPRIATE SQUARES FOR FOLLOWING QUESTIONS:

1. Who encouraged you to take Industrial Mathematics?
   Parents ☐ Counselor ☐
   Friends ☐ Your own idea ☐

2. When did you take Industrial Mathematics?
   Freshman ☐ Sophomore ☐
   Junior ☐ Senior ☐

3. How many years of high school mathematics had you taken prior to Industrial Mathematics?
   One year ☐
   Two years ☐
   None ☐

4. Do you feel Industrial Mathematics helped you in mathematics courses you took after completing Industrial Math?
   Algebra ☐
   Geometry ☐
   Gen. Math ☐

5. Did you take any industrial arts classes after completing Industrial Mathematics or at the same time?
   Before ☐
   After ☐
   Same time ☐

6. If so, do you think Industrial Math. helped you in these classes?
   Yes ☐
   No ☐

7. If you are now employed, do you think Industrial Math.
   (a) helped you get your job? Uncertain ☐ Yes ☐ No ☐
   (b) is helping you do your job better? Uncertain ☐ Yes ☐ No ☐

8. Did you take Industrial Math at Inglewood or Morningside High School? Inglewood ☐ Morningside ☐

9. Would you recommend Industrial Math to other students?
   Yes ☐ No ☐ Uncertain ☐

QUESTIONNAIRE B

TO: TEACHERS OF INDUSTRIAL MATHEMATICS

This questionnaire is one of four used to gather data for a Master's degree thesis. I will appreciate your cooperation in its completion.

SUMMARY OF INDUSTRIAL MATHEMATICS:

Industrial Mathematics is involved with the practical application of mathematics to the common everyday problems of our industrial culture. The solving of problems relating fractions, decimals, money, percentage, linear measure, board measure, square measure, cubic measure, and a detailed study of solving typical shop formulas are included in the course.

1. (a) Does the summary above cover your own course summary reasonably well?

   Yes ☐
   No ☐

   (b) If not, mention major differences:

2. Do you believe Industrial Mathematics is valuable to the majority of those students taking the course?

   Very Valuable ☐
   Valuable ☐
   Slight Value ☐

3. If you also teach other Industrial Arts classes, have you noticed evidence that students have transferred what they learned in Industrial Math to other I.A. classes?

   Often ☐
   Fairly Often ☐
   Seldom ☐

4. Are your Industrial Mathematics classes limited primarily to I.A. students, or do you get a cross-section?

   I.A. students ☐
   Cross-section ☐

5. Are the majority of your Industrial Mathematics students:

   Above Average ☐
   Average ☐
   Below Average ☐

6. What percentage of your Industrial Mathematics students are capable of handling high school algebra?

   50% ☐
   25% ☐
   10% ☐
   Less than 10% ☐

QUESTIONNAIRE C

TO: EMPLOYERS OF HIGH SCHOOL GRADUATES, INGLEWOOD SCHOOL DISTRICT

This questionnaire is one of four used to gather data for a Master's degree thesis. A thorough study is being made of Industrial Mathematics and its value to the student in obtaining and holding employment in this area.

SUMMARY OF INDUSTRIAL MATHEMATICS:

Industrial Mathematics is involved with the practical application of mathematics to the common everyday problems of our industrial culture. The solving of problems relating fractions, decimals, money, percentage, linear measure, board measure, square measure, cubic measure, and a detailed study of solving typical shop formulas are included in the course.

YOUR COOPERATION WILL BE APPRECIATED IN ANSWERING THE FOLLOWING QUESTIONS:

1. Do you check prospective employees' high school course records before hiring them?
   - Always ☐
   - Occasionally ☐
   - Unnecessary ☐

2. Would the Industrial Mathematics course as outlined above be helpful to potential employees who did not have school training beyond high school?
   - Very valuable ☐
   - Valuable ☐
   - Slight value ☐

3. Do you think the Industrial Mathematics course as outlined above would be beneficial to students who plan to take more specialized technical training before seeking employment in your field of business?
   - Very valuable ☐
   - Valuable ☐
   - Slight value ☐

4. Which would be of greater value to your non-specialized or semi-skilled employees - a course in algebra or geometry, or the industrial mathematics course?
   - Algebra ☐
   - Geometry ☐
   - Ind. Math ☐

5. Would you have any suggestions for improving the Industrial Mathematics course as outlined above?

QUESTIONNAIRE D

TO: TEACHERS OF PHYSICS, ALGEBRA, GEOMETRY, TRIGONOMETRY AND INDUSTRIAL ARTS

(Please indicate your field by underlining above)

This questionnaire is one of four used to gather data for a Master's degree thesis. I will appreciate your cooperation in its completion.

SUMMARY OF INDUSTRIAL MATHEMATICS:

Industrial Mathematics is involved with the practical application of mathematics to the common everyday problems of our industrial culture. The solving of problems relating fractions, decimals, money, percentage, linear measure, board measure, square measure, cubic measure, and a detailed study of solving typical shop formulas are included in the course.

1. Do you believe that Industrial Mathematics, as outlined above, would benefit students who enroll in your classes? What percentage?
   - 80% ☐
   - 60% ☐
   - 40% ☐
   - 30% ☐
   - Less than 30% ☐

2. Do you think Industrial Mathematics, as outlined above, has sufficient value to be maintained as an elective in the modern curriculum which is rapidly becoming overcrowded with requirements?
   - Yes ☐
   - No ☐

3. Can you see any similar value in a practical physics or applied mechanics course in the high school curriculum?
   - Yes ☐
   - No ☐

4. What percentage of high school boys, in your opinion, are capable of handling high school physics, algebra, geometry, and trigonometry?
   - 50% ☐
   - 35% ☐
   - 20% ☐
   - Less than 20% ☐

5. If you have suggestions of material or content that should be included in Industrial Mathematics, or which might be eliminated, please list:

EMPLOYERS SENT QUESTIONNAIRE C

Obear & Sons
940 W. Florence
Inglewood, Calif.

O.P. Grani Inc.,
1608 Orange
Alhambra, Calif.

Industrial Rubber Cement Co.
12909 Yukon
Hawthorne, Calif.

Pierce Engineering Co.
3609 Crenshaw
Inglewood, Calif.

Garret Corp.
AirResearch Aviation Service
6201 W. Imperial Highway
Los Angeles, Calif.

AirResearch Mfg. Co.
Div. of the Garret Corp.
9851 Sepulveda
Los Angeles, Calif.

Burton Electrical Engineering Co.
111 Maryland
El Segundo, Calif.

Consolidated Controls Corp.
750 Isis
Inglewood, Calif.

Control Switch Division of Controls Co. of America
139 Illinois
El Segundo, Calif.

Litton Industries
Corporate Offices
336 N. Foothill Blvd.
Redondo Beach, Calif.

Pre-Flite Equipment, Inc.
717 Hindry
Inglewood, Calif.

Semco Research, Inc.
212 W. Florence
Inglewood, Calif.

Douglas Aircraft Co., Inc.
3000 Ocean Park
Santa Monica, Calif.

Hughes Tool Co.
Aircraft Division
260 W. Beach
Inglewood, Calif.

Lockheed Aircraft Serv. Inc.
Honolulu Base
810 N. La Brea
Inglewood, Calif.

Northrop Corp.
Norair Division
1001 E. Broadway
Hawthorne, Calif.

Northrop Corp.
Nortonics Div.
222 N. Prairie
Hawthorne, Calif.

Ruleto Industries, Inc.
140 Oregon
El Segundo, Calif.

Delta Design Service
904 N. La Brea
Inglewood, Calif.

American Bitumuls & Asphalt Co.
1401 W. Florence
Inglewood, Calif.

Walker Body & Fender Works
513 S. La Brea Ave.
Inglewood, Calif.

American Motors Sales Corp.
601 Nash
El Segundo, Calif.

All Alum Prod.
11016 Inglewood Ave.
Inglewood, Calif.

Alco Mining Inc.
16908 S. Broadway
Gardena, Calif.

DeLucio Boats
125 Oregon
El Segundo, Calif.

Douglas Furniture Corp.
1920 E. Maple
El Segundo, Calif.

Kalpe Furn. Mfg. Co.
308 W. Florence
Inglewood, Calif.

Kroehler Mfg. Co.
311 W. Florence Ave.
Inglewood, Calif.

Regal Furniture Mfg., Inc.
405 Isis
Inglewood, Calif.

Virtue Bros. Mfg. Co.
5701 W. Century
Los Angeles, Calif.

Waycon Construction Co., Inc.
3940 Compton Blvd.
Lawndale, Calif.

Wm. C. Rogers Landscape Corp.
965 E. Hyde Pke.
Inglewood, Calif.

Olesen Co.
1535 Ivar
Los Angeles, Calif.

Inglewood Lumber Co.
201 W. Regent
Inglewood, Calif.

South Bay Lumber Co.
5300 W. 147th St.
Lawndale, Calif.

Great Western Lumber Corp.
8713 El Cleta
Downey, Calif.

Delta Engineering Co.
11146 S. Hawthorne
Inglewood, Calif.

Fisher Machine Shop Inc.
637 Isis
Inglewood, Calif.

Hobart Products
4045 W. Imperial Highway
Inglewood, Calif.

Metro Mfg. Co.
701 Augusta
Inglewood, Calif.

Inglewood Pattern
6533 West Blvd.
Inglewood, Calif.

Raco Products
1107 W. Hillcrest
Inglewood, Calif.

Arrow Plastic Molders
9805 Irwin
Inglewood, Calif.

Inglewood Tent & Awning Co.
333 E. Florence
Inglewood, Calif.

Standard Oil Company of California
324 West El Segundo
El Segundo, Calif.

Del Mar Engineering Labs.
6901 W. Imperial Highway
Los Angeles, California

Ampex Computer Products Co.
Inspection Dept.
8467 Beverly
Los Angeles, Calif.

Crush-Form Grinding, Inc.
221 Hindry Ave.
Inglewood, Calif.

Mattel Toys, Inc.
5150 W. Rosecrans
Hawthorne, Calif.

MISCELLANEOUS SUGGESTIONS FOR IMPROVEMENT OF INDUSTRIAL MATHEMATICS OFFERED BY VARIOUS PROSPECTIVE EMPLOYERS

An introduction to the basic trigonemetric functions would be beneficial.....Ampex Computer Products Co.

In addition to Industrial Mathematics it is becoming equally important that an applicant understand what a blue print is and how to read a plan or elevation view... Pierce Engineering Co.

Make certain that typical shop formulas are specialized for sheet metal, machine shop, etc...Robt. L. Ehinger, Personnel Manager, AirResearch Mfg. Co.

Sounds good for potential shop employees...Douglas Aircraft Co., Inc.

Include basic statistics - meaning of medium, mean, normal distribution, etc....Del Mar Engineering Laboratories.

Make every effort to assure that those who most need help are not over-shadowed by the few more aggressive students in the group...Control Switch Division of Controls Company of America.

What you have outlined above is what we have found all high school students to be lacking the most...Hughes Tool Co., Aircraft Division.